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March 1994

Electronics AUSTRALIA WITH ETI

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Nimbus and video CD's

UK based Nimbus Technology has developed a video CD format which would allow many consumers to use their existing audio CD players, with a small decoder. Lance Milne explains how it works — see page 18.

Make your own CD-ROMs?

For $14,000, you can now buy a CD-ROM authoring and mastering setup for a Macintosh computer. OMI's 'QuickTopix' system can produce multimedia discs which play on both Macs and PCs running Windows. (See page 124.)

On the cover

After many months of intensive training, NASA's STS 61 team of astronauts carried out a faultless in-orbit repair of the Hubble Space Telescope. It's now functioning superbly, as Kate Doolan explains in her story starting on page 26. (Cover pictures by courtesy of NASA)

Video and Audio

Features

Projects and Technical

Professional Electronics

Columns and Comments

Departments

MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE, VK2ZLO
GRAPHICS/PRODUCTION EDITOR
Milli Godden
TECHNICAL EDITOR
Rob Evans, CET (RMIT)
TECHNICAL CONSULTANT
Peter Phillips, B.Ed., Dip Ed., ECC
CONTRIBUTORS
Louis Challis
Arthur Cushen, MBE
Peter Lankshear
Jim Lawler, MTETIA
Tom Moffat, VK7TM
Neville Williams, FIREE, VK2XV
Major Al Younger (USAR, Ret.)
DRAFTING
Karen Rowlands
COVER DESIGNER
Clive Davis
PRODUCTION
Ray Eirth
CIRCULATION MANAGER
Michael Prior
PUBLISHER
Michael Hannan
ADVERTISING MANAGER
Selwyn Sayers
Phone (02) 353 0734; fax: (02) 353 0613.
ADVERTISING PRODUCTION
Karla Dixon, phone (02) 353 0713
SECRETARY
Ana Maria Zamora
HEAD OFFICE - EDITORIAL
P.O. Box 199, Alexandria 2015.
180 Bourke Road, Alexandria 2015.
Phone: (02) 353 0620. Fax: (02) 353 0613
Reader Services: Phone (02) 353 0620
Subscriptions enquiries: phone (02) 353 9992
Book Shop enquiries: phone (02) 353 9944
INTERSTATE ADVERTISING OFFICES
MELBOURNE: 504 Princes Highway, Noble Park, Vic 3174. Phone (03) 213 3222.
Fax: (03) 701 1534, Nikki Roche.
BRISBANE: 26 Chermside Street, Newstead, Qld 4006. Phone: (07) 854 1119.
Fax: (07) 252 3692, Graham Smith.
ADELAIDE: 98 Jervois Street, Torrensville, SA 5031. Phone: (08) 352 8666,
Fax: (08) 352 6033, Sue Bowshall.
PERTH: Allen & Associates, 54 Havelock Street, West Perth, WA 6005. Phone: (09) 321 2998,
Fax (09) 321 2940, Tony Allen.
UNITED KINGDOM: John Fairfax & Sons (Aust), 12 Norwich Street, London, EC4A 1BH.
Phone: (71) 353 9321, Fax: (71) 583 0348
ASIA: Headway Media Services Ltd, Room 2101, Causeway Bay Centre, 15-23 Sugar Street, Hong Kong. Phone: 516 8002,
Fax: (862) 890 4811, Adrian Batten.
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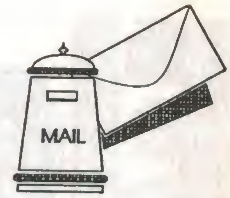
LETTERS TO THE EDITOR



Brickbat No.1...

It is indeed fortunate that Derryn Hinch is no longer in current affairs, for surely you would feature prominently in his shame file.

On thumbing through my complimentary copy of your January issue (which costs me about $1500 per issue), I could only recoil at the anti-social features in one of the articles. Given that the contributor admits to presiding over a madhouse, one should not be surprised.

Freon? Surely you are not promoting the use of an illegal and environmentally unfriendly substance? The view expressed by the author, 'But such small quantities are surely insignificant', is laughable. The amount in that almost part of Australia is added to the amounts, large and small used in the real world. It is a little like saying the effluent from my house is insignificant, it is all you other people causing the sewage problem!

Your publication should be encouraging readers to turn in the ozone murdering sprays, so they can be disposed of in an appropriate manner.

Peter Moon,
Semtech (NSW),
Lane Cove, NSW.

Comment: Your point is well taken, Peter, and others have expressed similar misgivings. We are suitably chastised, along with Tom Moffat.

Brickbat No.2...

I have just read the 'Information Centre' in the January issue of *EA*, and my frustration has caused me to put pen to paper. I am referring to your layout person's penchant for putting figures and diagrams on different pages to their reference in the text. I realise that sometimes there is not enough room for several diagrams to fit on the relevant page, but surely they should be placed together more often than not.

In illustration, refer to page 126 of the January issue. The 'Ring Simulator' refers to Fig.1 and Fig.2. Fig.2 is immediately below the text, but Fig.1 is on the previous page, requiring one to try to relate the diagram on one side of the sheet of paper with the text on the other. It looks like Fig.1 was positioned where it is on p.125 merely to break up the text. Surely, in a technical magazine, being 'pretty' should not take precedence over relevance? The same comment applies to Fig.3 and 4 (p.127). The text for both is not till page 129. I rest my case (three examples in one article).

Unfortunately, the examples given above are not unusual. I enjoy reading *Electronics Australia* each month, but find such poor examples of layout a real nuisance when trying to relate the text to the diagram. Diagrams etc., are given to help illustrate the text — surely they should be positioned in the best location to achieve this goal?

K. McGregor,
Turramurra, NSW.

Comment: We always try to have the diagrams as close as possible to their reference in the text, Mr McGregor, but at times other layout considerations make it necessary to move a diagram to another page.

...and a bouquet

Congratulations on your December 1993 issue. Your articles covered an incredible range from Palec to the Hubble telescope. I own a Palec exposure meter, which belonged to my late father. I have also had personal experience of the Panasonic 'Customer: Nobody, really' attitude expressed so well in the excellent article by Colin Dawson.

Your article on HP's LaserJet was also of great interest. I have a LaserJet 4 upgraded to 4M specification. Unfortunately, I also upgraded my program to Windows NT, then discovered that this does not support the 600dpi. This problem was acknowledged by both Microsoft and Hewlett-Packard, but neither company showed any interest in trying to correct it.

I trust you will still accept my best wishes, even at 300dpi.

Dr Ken Faulder,
Killara, NSW.

Not listed

In the November and December editions of *Electronics Australia* you ran an article on video editing using consumer equipment by Colin Dawson. At the end of the story, under Further Information (Sony), you mentioned two companies, one in relation to Professional Equipment.

As the owner of one of three Sony

professional dealerships in Sydney, I am curious as to why only one should be mentioned, or why any reference was made at all, as there was only one sentence dealing with professional equipment, which had little or nothing to do with the purpose of the article — Video Editing with Consumer Equipment.

I would appreciate your comments.

Should you require information relating to Sony Professional Equipment for any future article, we would be more than pleased to assist, including supply of equipment (if available!) for assessment.

Max Drummond,
Macray Specialised Services,
Artarmon, NSW.

Comment: Colin's listing wasn't intended to cover all dealers, Mr Drummond — that wouldn't have been feasible. The idea was to list some firms who could provide further information on the equipment discussed...

Old set available

I am a 74 year old retired Technical Officer ex Telecom Aust., Gawler telephone exchange and country district, and a long term reader of your magazine.

The recent 'Vintage Radio' article by Peter Lankshear describing a Russian receiver reminded me that I have a Russian chassis and turntable with pickup, which my son found in unwanted things being discarded by a person who was moving out of a house. My son was helping his friend to move in, and recovered the chassis and turntable, knowing my interest in unusual gear. Unfortunately the cabinet and loudspeakers were not with it.

It is a 'Rigonda Symphony' seven band receiver with variable selectivity IF and a rotatable ferrite antenna. It also has automatic tuning (motor driven).

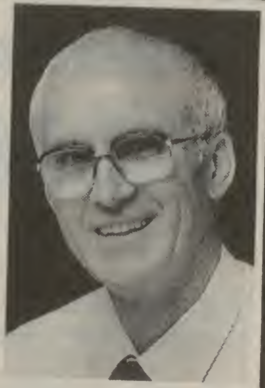
Some valves were broken, but a 6BA6 proved to be a direct replacement for an IF amp valve. It has push-pull output and I was able to use two 6M5 valves in the output stages (stereo) by bridging two valve socket pins. The receiver is now in working order with the exception of the VHF tuner.

If anyone is interested and could find a good home for the receiver, please contact me if you know of someone travelling interstate who could collect it.

G.G. Gregory,
Evanston Park, SA.
Phone (085) 222 006.

Letters published in this column express the opinions of the correspondents concerned, and do not necessarily reflect the opinions or policies of the staff or publisher of Electronics Australia. We reserve the right to edit letters which are very long or potentially defamatory.

EDITORIAL VIEWPOINT



Good news for astronomy as well as for NASA

It's always a bit risky, when you're producing a monthly magazine, to publish an article which is planned to coincide with a forthcoming event. Our lead times are inevitably longer than with a daily or weekly publication, and as a result there's an increased risk that things will change in an unpredictable way before such an article is published. I was therefore somewhat nervous when we prepared Kate Doolan's 'preview' feature story on NASA's mission STS 61, the one about repairing the Hubble Space Telescope, for last December's issue.

Luckily, the mission launch took place within a day of the predicted time, only a few days after we published. Not only that, but everything about the astronauts' repairs to the HST went according to plan — so Kate's preview article turned out to be right on target too. (Whew — thanks, everyone!)

Soon after the Shuttle had landed, NASA then sent Kate a big parcel of further material, including some really good pictures. As a result she immediately started working on a 'what actually happened' story, and as promised we have that for you this month. You'll find it on pages 26-32, and it makes fascinating reading.

I guess what makes the follow-up story even more relevant is that NASA has subsequently released the results of its tests of the repaired Hubble, and according to these, the telescope is now giving even sharper images than they had dared hope — which is of course great news for the world's astronomers, as well as boosting NASA's stocks enormously.

In a day or two, I hope to receive copies of the first images taken with the refurbished HST, and I'm told they're quite impressive. If so, we'll try to publish a few of them next month for your interest.

In the meantime, there's another article in this month's issue that I feel sure you'll want to read. Written by television engineer Lance Milne, it's about those new digital video compression systems and the way they look set to bring CD-video into our homes, in the next year or two. Lance also discusses the role played in all this by British firm Nimbus Technology, which has developed a video CD format capable of being played back via many existing audio CD players, using a low-cost decoder box.

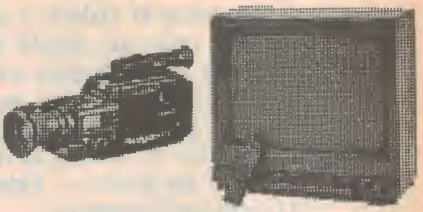
Also in this issue we have a review by Louis Challis of the new Philips DCC130 portable DCC player, which Louis says provides a level of sound quality almost indistinguishable from standard CDs.

We haven't forgotten those who like to *build* electronics projects as well as reading about the latest technology, either. You'll find no fewer than *five* projects in this issue, ranging from Rob Evans' superb new Playmaster Pro Series 3 amplifier, to a little 'reaction timer' based on a low cost microcomputer chip.

All in all, then, I'm confident you'll find more than enough material to keep you busy reading and building, until next month.

Jim Rowe

What's New in VIDEO and AUDIO



Super-VHSC 'palmcorder' released

A new compact Super VHS 'Palmcorder' called the NV-S85A has been released by Panasonic. This new Camcorder offers high picture and sound quality, coupled with the ease of use and versatility of 'Palmcorders'. The S85 uses the Super VHS-C format and hifi stereo, which gives a significantly clearer picture and superior quality audio.

According to Panasonic's Visual Product Manager, Marc Bonney, "The S85 incorporates the latest technology in home movie cameras featuring a new digital 'crystal-clear' processing system and 'crystal-clear' auto white balance system. The result is superb picture quality with outstanding, natural colour reproduction."

"The S85 is also the first movie camera to offer both VITC (vertical interval time code) 'Write' and 'Read' functions, to provide professional grade editing time coding by giving each picture signal a time code. The audio dubbing also allows for creative editing," added Mr Bonney. In an effort to increase the life of the rechargeable batteries, Panasonic has added an 'Auto Power Saver'. The camera automatically turns the viewfinder and auto focus off when the user takes the camera away from the face during a 'pause' in shooting.

The 'Auto Power Saver' reduces power consumption by up to one watt, saving valuable battery power.

Featuring a 'Digital Image Stabiliser, 10x to 20x digital zoom and five easy to use creative digital functions including digital strobe, wipe, mix, gain-up and snapshot recording, the S85 allows the user to add professional, creative touches to their video production.

The NV-S85A Palmcorder is available from electrical retailers at a recommended retail price of $3199.

Akai's 68cm 'home cinema' CTV

Akai has announced the CTK-2976, a 68cm A/V stereo colour TV that is aimed at the 'home cinema' market.

Offering an S-VHS SCART input, the CTK-2976 offers picture detail required to meet current high resolution S-VHS formats.

A built-in hifi stereo 12 watt amplifier is designed to 'bring to life' stereo sound tracks on video rentals. There are also additional stereo outputs to connect to a users' existing hifi system.

The CTK-2976 also boasts Multi Video Intelligent Terminal (MVIT) technology which enables viewing of NTSC software.

This convenient feature is most desirable in Australia as some video disc players and a larger selection of laserdisc titles are in the NTSC format. The set also features Akai's 'easy to read' on-screen display. All commands activated via the remote appear on the screen.

The CTK-2976 has an RRP of $1499 and is covered by a 12 months warranty. For further information of your nearest Akai dealer please phone (02) 763 6300.

New subwoofers from Kenwood

Recipients of a 93/94 CESA Award for 'Best Car Audio System' (over 150 watts), Kenwood has recently supplemented its car speaker line up with the addition of four new subwoofers. Designed to enhance the firm's car audio systems, the new subwoofers provide the rich bottom octave often found lacking.

Sporting a new 'logo', the new subwoofer line up comprises four models ranging from 152mm (6") to 304mm (12") diameters and with power handling ability from 150 to 450 watts peak.

The new subwoofers employ heavy duty double layer strontium-ferrite magnets specially selected for their high density magnetic fields. The end result is a line up of subwoofers that can deliver deep extended bass and at the same time transient detail that enables true sound quality. Other technologies include wide bore voice coils and triple spiders made of polyamide elastomer for greater power handling and reliable long excursion operation.

To further reduce distortion and provide a more gentle attenuation of high frequencies, Kenwood employ non-pressed injected polypropylene cones with concave centre caps. Polypropylene is almost an ideal speaker material and is specially chosen for its outstanding properties such as low colouration and immunity against environmental extremes.

All models feature large gold-plated terminals specially designed to prevent corrosion and maximise conductivity. These terminals can accept banana plugs and large gauge quality speaker cable.

Portable DCC player from Panasonic

Panasonic Australia has released its first portable DCC (digital compact cassette) player, following the successful release of its RS-DC10 player/recorder in March last year.

The Panasonic RQ-DP7 is a light and compact unit which weighs only 500 grams (one pound) and measures less than 36mm high and 120mm wide.The RQ-DP7 is equipped with S-XBS (Super Extra Bass System) for improved bass response. In addition there is Dolby NR for playback of analog cassettes.

Playback of standard analog cassettes is made possible by a combination head which is half digital/half analog. The unit automatically detects whether it's a DCC or analog cassette and plays back accordingly.

The built-in rechargeable battery gives the user about two and a half hours of continuous DCC playback. To conserve battery life, the power turns off automatically if no buttons are pressed within four minutes of finishing playback. The RQ-DP7 runs on either the battery or AC power (the AC adaptor doubles as a battery recharger). The AC adaptor has multi voltage capabilities, allowing it to be used overseas where different voltage levels are used.

Pre-recorded DCC cassettes include data for displaying album, song titles and artist name. The large LCD display on the RQ-DP7 shows up to 12 characters of information. A handy wired remote control allows the user to control all the major functions including tape direction, play, fast forward, rewind and skip.

Bookshelf speakers from Celestion

Celestion's newly ported Model 3, 5 and 7 bookshelf loudspeakers all boast improved bass response, higher sensitivity and increased power handling, with no increase in cabinet size.

All three feature bass reflex ports on the rear of their cabinets, resulting in an extension of bass response, with a useful rise in sensitivity and power handling. The highly praised Model 3 MkII has already been awarded a five star rating by UK's *What Hi-Fi* magazine. The three MkII models all incorporate their original driver units, featuring Celestion's two piece, 25mm titanium dome tweeter and felted fibre cone bass/midrange driver.

The Celestion 3 MkII delivers 62Hz to 20kHz frequency response, 91dB SPL sensitivity (1W/1-metre) and 75 watts programme power handling in an 8L vented cabinet; the Model 5 MkII offers 62Hz to 20kHz frequency response, 92dB SPL sensitivity (1W/1-metre) and 90 watts programme power handling in a 12L vented cabinet; and the Model 7 MkII boasts 57Hz to 20kHz frequency response, 92dB SPL sensitivity (1W/1-metre) and 120 watts programme power handling in a 27L vented cabinet.

All new MkII models feature five element, second order low and high pass crossovers, colour coded 4mm binding post terminals and high density particle board cabinets, finished in a simulated black ash or oak veneers.

Recommended retail prices are: Model 3, $639/pair; Model 5, $759/pair; and Model 7, $1059/pair. Celestion is represented throughout Australia by Amber Technology.

Onkyo receivers with Pro-Logic

The new TX-SV515PRO and TX-SV313PRO are part of Onkyo's new line up of Dolby Pro-Logic equipped surround sound receivers. Both models feature comprehensive facilities and incorporate video signal routing, making them the ideal audio/video control centre in home entertainment systems.

Onkyo claims its new high performance receivers boast enough output power to turn any room into a first-rate home theatre. The TX-SV515PRO delivers 80 watts per channel in stereo mode, and in surround mode 55 watts per channel, to the left, right and centre, plus 20 watts per channel to the rear.

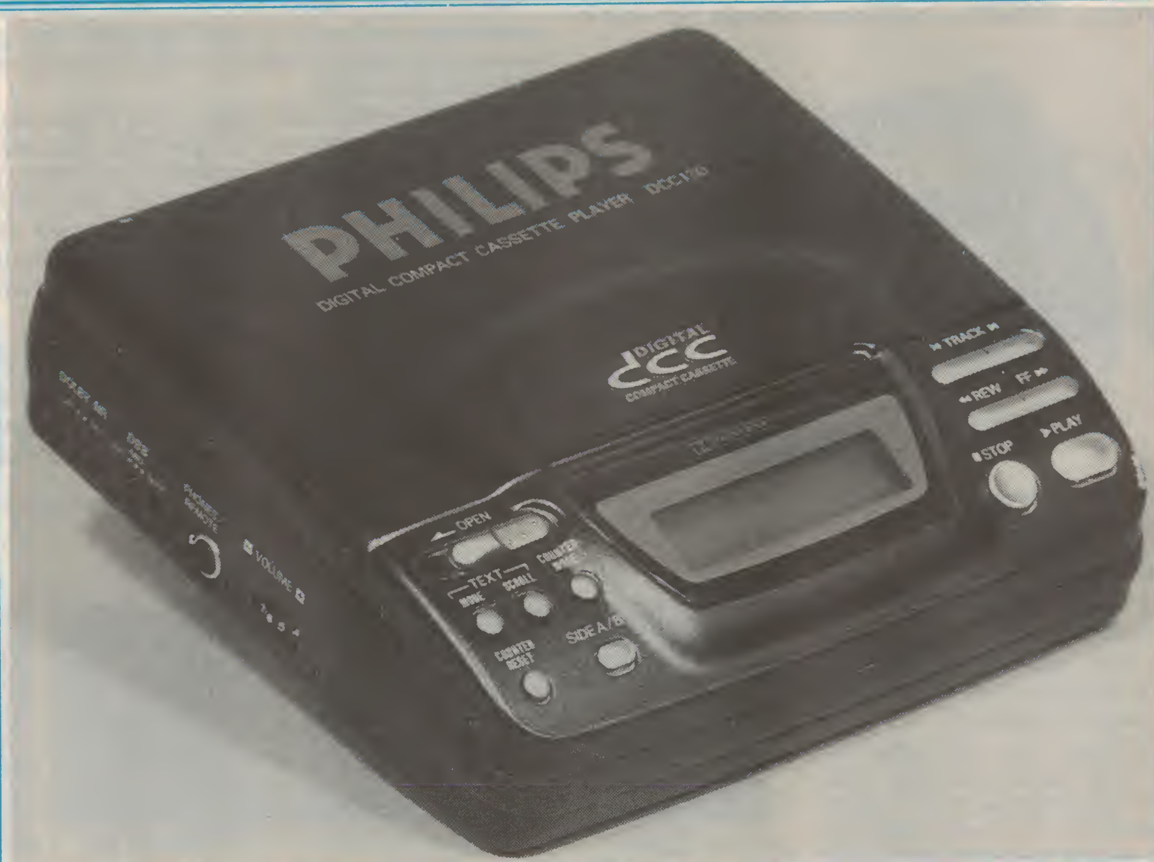
If power requirements aren't as great, the TX-SV313PRO delivers 60 watts per channel in stereo mode, enough to effortlessly drive most lowimpedance loads. In surround mode it delivers 55 watts per channel to the front, 15 watts to the centre channel, plus 15 watts per channel to the rear.

Entirely discrete output stage amplifiers are employed for all five channels of the TX-SV515PRO, and for each of the front channels in the TX-SV313PRO. The result is uncommonly low noise levels in all amplifier circuits, providing transparent, clean performance and greater dynamic range.

The elaborate built-in Dolby Pro-Logic system in both receivers faithfully recaptures the surround information previously only heard in cinemas. Employing sophisticated adaptive matrix circuitry, dominant sound is 'steered' to the appropriate channel while simultaneously reducing the level of the other channels. The result is much greater channel separation (up to a full 25dB) and a more realistic sound effect.

Both receivers also feature selective tone control, adjustable digital delay, a motor driven volume control, 40-station FM/AM random preset tuning with six programmable memory presets, and a full RI compatible remote control. Recommended retail prices for these new receivers are $1299 for the TX-SV515PRO and $999 for the TX-SV313PRO.

For further information circle 181 on the reader service coupon or contact Amber Technology, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211. ❖



PHILIPS' DCC130 PORTABLE DCC PLAYER

This month Louis Challis turned his attention to the new Philips portable player for digital compact cassettes. With more time than usual to evaluate it, he used it to carry out extended comparisons between DCC and standard CD versions of many pieces of music — and ended up more impressed than ever with DCC technology, as well as with the DCC130 player itself...

I've often wondered how significant purchase price is, in the minds of the public, when assessing a new piece of consumer equipment. There's little doubt that Philips had to consider this question very carefully late last year, following its release of the Digital Compact Cassette (DCC) tape recorder and player systems some months previously.

If we tactfully ignore Philips' initial embarrassment and acknowledge that it has now taken a bold step (or rather should I put it more bluntly, its only possible step), by slashing the price of the DCC equipment, we can only hope that the public will now return to the shops to re-appraise its virtues.

As I see it, DCC is without a doubt one of the most exciting technological developments of the 90's in terms of music reproduction. Most of you are undoubtedly aware that it follows fairly closely on the heels of Philips' prior development of the compact disc. Each of these respective systems has been designed to cater for a different market. Without Philips' prior development, and the market's universal acceptance of CDs, it is doubtful whether Philips would have seriously contemplated either the development or the marketing of DCC.

In the 1960's Philips invented the ubiquitous Compact Cassette player, and in the 30 years following, hundreds of millions of compact cassette players and billions of cassettes have been produced. As

good as compact cassettes have become, following that 30 years of development, it would have been virtually impossible to 'boot-strap' the compact cassette players' performance any further. Today the industry and the public have to decide whether DCC is the natural successor to Philips' tried and well-proven original cassette player development.

When the DCC130 was released in Japan in June, Philips hoped to attract a whole new segment of purchasers to DCC. Now that the DCC130's selling price has been reduced by a third, the public will undoubtedly review its prior disdain for the portable DCC format, as its technical performance and functional attributes are sufficiently exciting to win over the 'ears and minds' of the yuppie generation.

Now although I could be wrong, it appears to me that the DCC130 has been designed in Osaka, possibly by Matsushita, and that the DCC130 is simply a re-badged and cosmetically re-engineered Panasonic RQ-DP7 portable DCC player. Yes, I know the top cover is different, but a close examination of the two units at last year's CES left me with relatively few doubts as to who designed the respective portable DCC players, and more pointedly in whose plant they have been manufactured.

Ideal for joggers

Be that as it may, the DCC130's design philosophy is simple and from an ergonomic standpoint, perfect for the jogger or the cyclist, or for a traveller who wishes to enjoy his music when commuting to and from work. The designers have achieved commendable results, and have produced a quality product in a relatively minuscule package. When used away from home or mains, and when powered by its internal removable nickel cadmium battery, it would normally be carried or used in the pouch provided — which can be either strapped to a belt or placed in a jacket pocket (provided it is suitably large).

The most important controls for the jogger, cyclist or traveller have been incorporated into the lead of the miniature earphones. There are three primary buttons provided for OPERATE (or PLAYBACK), FAST FORWARD, and REVERSE. A fourth HOLD switch has also been provided so that the controls may be locked into the selected mode. When used appropriately, in accordance with a characteristically Japanese logic which is outlined on the second last page of the handbook, these controls also make it possible to play back from the reverse side of a tape. Also, provided you know the number of a specific track that you wish to advance or reverse to, from the current track, you can get there by cyclically depressing the FAST FORWARD or REVERSE buttons.

The earphones conveniently signal the number of times that you have depressed the FAST FORWARD or REVERSE buttons with a series of reassuring beeps, so that you can aurally monitor your instructions. Whilst this system works, it is not the easiest nor simplest approach to solving the problem.

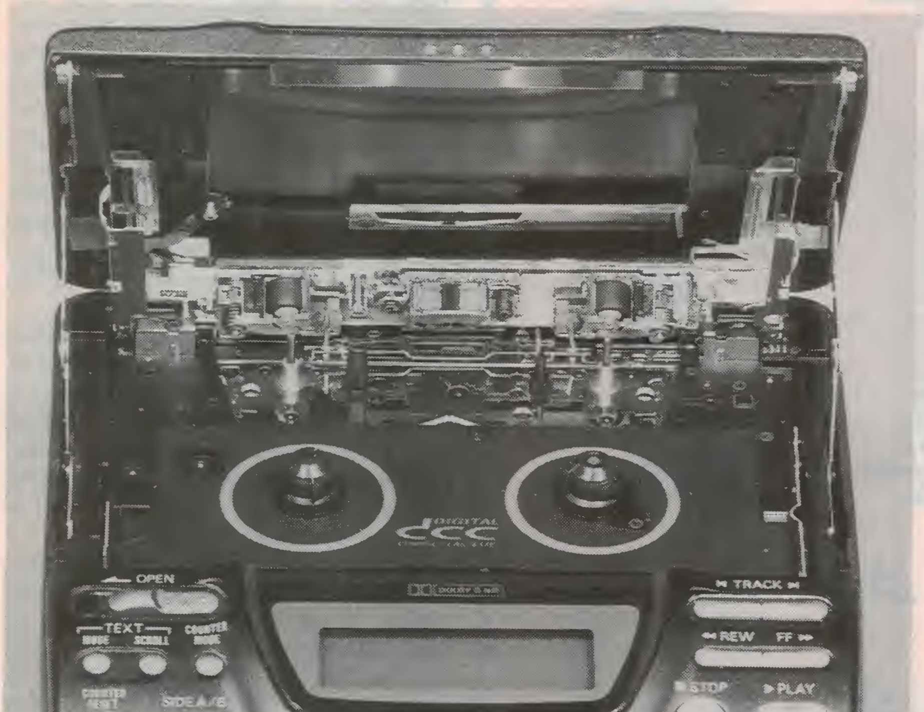
On close examination, the DCC130 incorporates a larger number of controls than I might otherwise have expected. On the rear left of the leading edge of the front panel, a simple slide switch is provided through which the hinged lid can be unlocked. After opening and lifting the cover, the DCC cassette or conventional compact cassette is simply inserted into a pair of side channels attached to the underside of the lid, prior to closing it ready for use.

The most important controls are provided on both sides of the small central LCD display. On the right-hand side are a pair of buttons through which you key in the number of tracks that you wish to advance or rewind the tape.

The central LCD display shows the appropriate number of tracks that are to be advanced, or rewound, at its right-hand edge. A similar pair of buttons are provided for REWIND or FAST FORWARD, as are two additional buttons for STOP and PLAY.

Each pre-recorded DCC cassette incorporates the title of the tape, the name or names of the performers, and the title of the track in the sub-code information contained within the track. This information may be interrogated by means of a pair of buttons which are located on the left-hand side of the front panel. These colour coded buttons allow the text to be scrolled, so as to make full use of what would otherwise prove to be an unusually small display.

The COUNTER MODE button, which is adjacent, provides timing information in minutes and seconds, in relation to the track being played, as well as information on the total number of tracks and total playing time. An additional small button is provided for COUNTER RESET, and a



A view inside the DCC 130. Visible at the rear of the cassette well in the lid are the thin-film head (centre) and the twin pinch-rollers, with the matching twin capstans visible below each pinch-roller.

slightly larger button for selecting side 'A' or 'B' of the tape.

On the left-hand side of the player, switches are provided for selection of Dolby 'B' noise reduction (which many pre-recorded compact cassettes now feature). A two-position switch is provided for selecting two different levels of bass boost.

A special multi circuit tip ring and sleeve socket has been provided to encompass the special requirements of audio output and remote control functions, and this is positioned at the middle of the left-hand side of the player. Earphone volume control is provided through a rotary 'thumbwheel' volume control (with numbered settings), which is accessible through the side of the carrying case.

The right-hand side of the player incorporates only two controls, a HOLD switch and a REVERSE MODE switch through which repetitive reverse replay, or a double-sided replay may be selected.

The rear panel has sockets for a 5.5 volt external DC supply, which is provided by means of a special lead from the battery recharger.

A miniature tip ring and sleeve line socket with matching lead is provided to connect the player's output directly into your hifi system. An additional digital output socket is also provided, for interconnecting the player's output directly into a digital input of a hifi system or separate recorder.

The underside of the player has an operable lock and removable cover, through which the rechargeable nickel cadmium battery (4.8 volts, with 1.3 amp-hour capacity and approximately 2.5 hour playing time). The battery can easily be removed and placed in the charger provided, when the battery voltage drops too low.

Whilst these multiple controls and facilities may sound complex, with very little practice they prove to be relatively straightforward, even though the handbook's functional descriptions fell short of what most novices might reasonably expect.

In point of fact, relatively few purchasers are likely to seriously or frequently use the 'discontinuous multiple track selection' mode, and the provision of these facilities on the miniature earpiece cord appears to primarily pander to the Japanese market, which historically craves for gimmicks of that type.

Measured Performance of Philips DCC130 Portable Player
Model No: DCC130 - Serial No: Z00 9327 040145

1. Frequency response

DCC	Digital Format 20Hz to 20kHz + 0/-0.3dB	
Standard Compact Cassette (Reference Replay Tape)	Type 1	30Hz to 15kHz + 0/-3dB
	Type 4	45Hz to 11kHz +/-3dB

2. Linearity

Reference Level	Measured Output Level
0dB	0.0dB
-1.0	-1.0
-3.0	-3.0
-6.0	-6.0
-10.0	-10.0
-20.0	-20.0
-30.0	-30.0
-40.0	-40.0
-50.0	-49.9
-60.0	-60.0
-70.0	-69.8
-80.0	-79.9
-90.0	-89.9
-92.0	-92.1
-96.0	-96.1
-102.0	-100.9
-105.0	-103.5

3. Channel separation

Frequency	Right into Left Channel
1kHz	-81.1dB

4. Distortion (@ 1kHz)

Reference Level	2nd	3rd	4th	5th	THD %
0	<-80.0	<-80.0	<-80.0	<-80.0	<.01
-1.0	-	-	-	-	<.01
-3.0	-	-	-	-	<.01
-6.0	-	-	-	-	<.01
-10	<-80.0	-75.5	-76.9	-80.0	.025
-20	-73.2	-71.9	-79.0	<-80.00	.03
-30	-72.9	-73.1	-	<-80.0	.03
-40	-71.6	-62.1	-73.4	<-80.0	.09
-50	-64.3	-54.3	-60.6	-70.0	.22
-60	-56.9	-51.2	-51.7	-49.8	.45
-70	-50.4	-45.2	Below	-46.1	.8
-80	-39.5	-32.9	Below	-35.1	3.2
-90	Below	-23.5	Below	-24.0	9

5. Signal to noise ratio utilising test track with -105dB reference signal — corrected for signal contribution

85dB(Lin) 96.5dB(A)

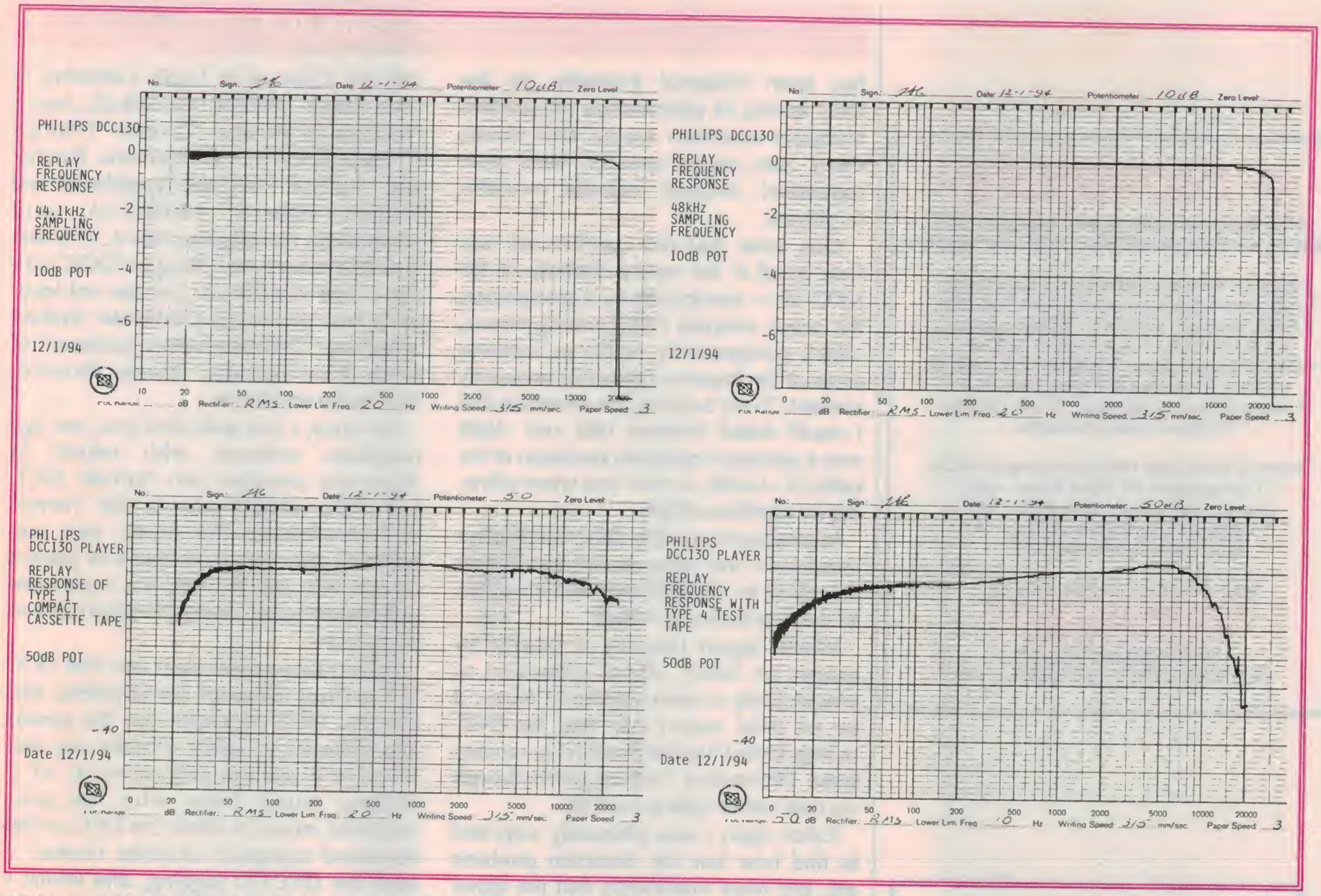
Interleaved testing

The Christmas holidays interceded with my normal testing and reviewing schedule, and Philips were kind enough to provide a selection of pre-recorded DCC tapes — many of which were accompanied by matching CDs, at my request. I spent a number of days listening to the pre-recorded tapes, and performing direct 'A-B' comparisons between the DCC tapes and the CDs, before I got around to performing my objective tests in the laboratory. However when I did perform the objective testing, the results proved to be far better than I might have imagined on the basis of my initial DCC recorder review, some 12 months ago.

Thus by way of example, the measured replay frequency response of the DCC130 with a DCC reference test tape displayed an outstanding frequency linearity, with a maximum droop of only 0.3dB at the lower and upper frequency limits of 20Hz and 20kHz (using a test signal with a 44.1kHz sampling frequency).

As I discovered, the user has no control over the sampling frequency, as the player simply adjusts automatically to the encoded sampling frequency on the pre-recorded tape — most of which will use a sampling frequency of 44.1kHz, the same as CDs.

With the sampling frequency increased to 48kHz, the frequency response was even flatter, and the high frequency droop was less than 0.2dB at 20kHz. I was surprised that the replay frequency response was so good, particularly as at least two or three other reviewers had extensively played with this particular unit before it even got to me.



At top are the replay response plots for the DCC 130 in digital mode, for sampling frequencies of 44.1 and 48kHz. The lower pair of plots are for the machine playing back analog recordings, using type 1 tape (left) and type 4 tape.

I decided that it would be desirable to evaluate the player's replay performance when using conventional compact cassettes. I was pleasantly surprised to find that the replay frequency response (at the -20VU level) was 30Hz to 15kHz +0/-3dB. When you think about it, that performance is pretty good, if not outstanding. The replay frequency response with a type four TDK metal reference replay tape was not quite as good, and the measured frequency response was 45Hz to 11kHz +0/-3dB. It is apparent to me that the DCC130 has been optimised for replay of type one tapes, and particularly type one pre-recorded tapes, which dominate the market.

When you consider that the DCC130

has been designed primarily for the DCC format, its performance on standard compact cassettes would still shame many new mains operated (and more expensive) compact cassette recorders or players.

One issue that did concern me was how good is the replay linearity of the DCC130 — particularly as it incorporates the much vaunted PASC coding format, which prospectively masks or removes some of the important dynamic frequency content. To my surprise, the deviation that I could detect between 0dB and -96dB was a potential maximum deviation of the order of +0.2dB, or even less when allowing for significant digits.

In practical terms the DCC130 displays minuscule and what would be at best described as 'insignificant non-linearity', all the way down to -100dB.

Whilst signal linearity is clearly no longer an issue, signal distortion is prospectively a more significant factor, if for no other reason than that the PASC coding format has the potential to remove some information content (even though we may not be able to hear it).

Once again I was pleasantly surprised to find how low the distortion products are, and more importantly that the signal level has to drop to below -70dB before the 1% THD level is found.

The distortion levels only really start to significantly climb once the signal levels drop below -50dB, and nasty distortions, which are primarily associated with the limited number of signal bits, only manifest themselves once you go below -80dB.

The measured distortion characteristics of the DCC130 player were significantly better than I would have expected, and agreed well with my subjective assessment of detectable distortion and the overall quality of replay of the DCC130 on pre-recorded material.

The measured signal to noise ratio of the DCC130 proved to be marginally less than the handbook claimed, which I measured as 85dB unweighted and 96dB A-weighted, whilst the handbook claimed 92dB. I similarly measured a channel separation of 81dB at 1kHz, whilst the handbook claims a marginally higher figure of greater than 90dB.

Overall, the objective performance of the DCC130 proved to be positively outstanding, and significantly better than I would have expected from a portable player with such minuscule dimensions.

The DCC cassettes and CDs with which I was provided included Kiri Te Kanawa and the Choir of St Paul's Cathedral in 'Ave Maria' (Philips 412629-5), Jessye Norman in Bizet's 'Carmen' (Philips 426040-5), Carl Orff's 'Carmina Burana' with the San Francisco Symphony and Chorus (Decca 430509-5), and Beethoven's Symphonies Nos 4, 5, 6 and 7 with Herbert von Karajan (DGG 439 003-5 and 439-004-5). Last but not least, there was the Stuart Challender Sydney Symphony Orchestra with a potpourri of music from Borodin, Strauss, Brahms, Sculthorpe and Ravel.

For once, I had sufficient time and appropriate software with which to rigorously compare two formats (DCC and CD), without any of the normal time restrictions. The music was outstanding, the vocal content was perfect for the task, and the task was a pleasure rather than being simply described as part of my work.

What I came to perceive was that DCC is a brilliant technical development, and that the DCC130 player has the power and potential to satisfy virtually any and all of the normal requirements of a serious music lover who has prerecorded music in either the DCC or the standard compact cassette format. I took the DCC130 jogging, and whilst I did not have the 2.5 hour staying power of the batteries, the DCC130 just didn't miss a beat.

At home when plugged into my hifi system, the $2000 CD player with which it was compared couldn't outperform the DCC130. Obviously on occasions I was able to detect (or at least I thought I could detect) some slight differences, but they just weren't significant — and more pointedly, I could not say which source was the better or which was the worse in such comparisons.

After four weeks of serious listening, I decided that DCC is worth the time and effort, particularly as it is backward compatible. I for one have dozens, if not hundreds, of pre-recorded tapes with which to supplement the pre-recorded DCC tapes that I will ultimately buy.

At $1000 plus, a DCC130 player was simply too expensive. At the new RRP of $699, and an expected selling or discounted price somewhat below that figure, it is good value for money. I for one will end up buying one...

The physical dimensions of the DCC130 are 120mm wide by 118mm deep by 36mm high, and it weighs only 490 grams (including battery). You should find it at most of the better audio dealers. ❖

Moffat's Madhouse...

by TOM MOFFAT

Reflections on getting jabbed...

What's a good fun thing to do today? How about going to the dentist? Yes? No! Because dentists have drills, and despite new technology and high speed motors and soothing music in the headphones, dentist drills are still a most unpleasant experience.

Now, perhaps relief is in sight, with the development of a laser dentist's drill. No more spinning little burrs, no more jackhammer in the head, just a beam of light. I can see it now: Sizzzzz... and a little wisp of smoke comes up and travels through your sinus up into your nostril and your olfactory nerves send a message to your brain: 'Nose to mission control! I think our teeth are on fire!'

All right, so there is no such thing as a 'pleasant' dentist drill. We simply replace abrasion with heat. But it's probably easier for the dentist, what with fewer bits of fragmented teeth flying around and maybe a little less blood. But it still hurts, because we've forgotten one thing: the INJECTION!

Yes, my friends, we're talking about that great big silvery syringe with the special finger-holds on the side and the metal ring in the plunger, so the operator can exert enormous pressure to force various juices into the darkest recesses of your head.

We all know what it's like: the needle, longer than your finger, goes in, and in, and in, and soon it has passed your jaw and it's up level with your ears and now it's in your BRAIN! And the dentist says "See, that didn't hurt a bit!". To see a REAL dentist in action, permit me to recommend the film *Little Shop of Horrors*; it's out on video.

But I digress. What I'm really thinking of is not a replacement for the dentist drill, but a replacement for the hypodermic needle. That's what we REALLY need.

I know there are such things as those guns that shoot a blast of stuff into your arm by high pressure alone. I've never had the pleasure of meeting one of those, but I'm told by people who have that they hurt worse than the needle...

We all have our needle nightmares. I once spent Christmas in hospital with peritonitis, and had it not been for the hypodermic needle and the antibiotics it delivered, I would be dead by now. So I should be thankful. But this particular needle was a whopper, big and thick and connected to an enormous reservoir of white goo that the nurses forced into my bottom with considerable glee.

This procedure was repeated every six hours, day and night, over several days. And one of those days was Christmas Eve. The nurses, like everyone else, had a little celebration. And when midnight came around and it was time for my next needle, the nurse reeled through the door right on time. Yes, reeled — staggered. It had been quite a party, and she was sloshed to the eyeballs and coming at me with this horse syringe.

I closed my eyes and gritted my teeth and then the thing hit me in the back of the leg. "Sho shorry, Mr. Moffat, I sheem to have missed. We'll try again". It took three tries before the deed was done.

The same nurse was back on duty the next afternoon, not looking real flash but at least sober. There was no apology for last night's difficulties. I doubt she remembered. I was kind and didn't remind her.

During the last election campaign there was a lot of talk about over-use of Australia's health services. Each party had its own ideas on how to reduce the tendency of people to go to the doctor at the drop of a hat, because it was 'free'. Well, I have the solution: make needles compulsory.

When I was a kid, growing up in the USA, every visit to the doctor's surgery ended with a needle, or a 'shot' as they are called in that country. And from what I hear, the situation hasn't changed much in modern times. American doctors are still needle-happy.

In Australia, kids have learned that a visit to the doctor is usually rewarded with a few days off school. There is nothing to lose, other than $30 or so sucked from the national health system, and everything to gain. So, on the day of a big exam or something, the kid suddenly develops the most awful cold and is carted off to the doctor. Often the only treatment is 'a few days off'.

Not so in my day. Let me set the scene, and many of you may have already seen it. Remember the film *The Right Stuff*, about the training of America's astronauts? There was this very funny sequence when the astronauts were undergoing their medical examinations. This activity took place at the Lovelace Clinic, in my home town of Albuquerque, New Mexico. And I am almost certain the scenes were actually filmed there, or in a pretty good studio mock-up. Because the minute I saw the waiting room, I immediately recognised it and felt a surge of panic. The Lovelace Clinic was the closest medical facility to my home, so that's where I was taken for visits to the doctor.

There was a large open area filled with chairs. At the front was a counter staffed by nurses, and off to the right was a long hallway, lined on both sides by doctors' surgeries. There must have been at least 30 of them; this was a BIG operation. The chairs as I remember were filled with mothers, each firmly gripping the wrist of a kid so as to prevent escape.

Every couple of minutes there would be this enormous shriek from down the hall. We all knew that the kid had just got his shot, and that was the end of the consultation. It also meant that somebody else was 'next'. Who would it be? This brought on that familiar panic feeling: 'Please, God, don't let it be me!'.

About this time the new injectee would shoot out the mouth of that hallway like out of the muzzle of a cannon, across the waiting room and out the door to the carpark. There was always the worry that the doctor had actually meant to give TWO shots,

so it was wise to make oneself as scarce as possible before the doctor realised his mistake!

Mother would soon follow and front up to the counter to pay the doctor's bill. The nurse, seeing that Dr Pain was free, would then call out "Mrs Moffat?". Well, that was it. What to do? If she loosened her grip slightly, maybe I could follow that last kid and bolt out the door. But Mum could read minds, and her hand grew tighter. Doomed!

Once, only once, did I find a visit to the Lovelace Clinic a satisfying experience. We went through the usual routine; iron-gripped Mummy dragging me down the Hallway of Terror into the lair of Dr Pain, for treatment of a case of the sniffles. As it turned out the cheapskate wouldn't even give me any time off school, but he decided on a penicillin shot just for good measure. So what's new?

He only had the one room, so I got to watch every detail as he prepared the syringe, a big heavy one with an enormous fat needle. He had this big bottle of thick white gooey stuff, which looked just like the pus it was supposed to prevent. He plunged the needle through the bottle's rubber top, a practice run for my skin. Then he used the plunger to suck and slurp the goo until the syringe was almost full. This was to be a 'magnum' load...

Then the doctor's face took on that familiar grin of sadistic anticipation, or so it seemed to me. "All right Tommy, roll up your sleeve..." (Last chance: can I bolt? No, the door was firmly closed. Could I faint? That would be sort of a natural anesthetic. Come on Tom, faint, faint!) It didn't work.

Then came that cold feeling of a ball of cotton swabbing metholated spirits onto the target area on my arm. Not long now. Strapping me into the electric chair. And then WHAM! The needle hit home and the doctor started squeezing that plunger like crazy to force his horrible goo out of the syringe and into my poor, scrry, painful, non-deserving arm.

And then the syringe exploded. Not the glass part — the needle simply came adrift from its fitting, leaving a nice, wide hole through which the penicillin could spurt like pus from a squeezed pimple. It happened so fast the doctor couldn't get the pressure off, so the syringe's whole contents jetted out the end, against my arm instead of into it — and then, like from a garden sprinkler, all over the room.

The doctor had this nice glass-fronted display case in which he kept his collection of horse syringes and other useful implements of torture. The glass was now decorated by large dollops of white goo. There was a big light fitting in the ceiling, from which white goo now dripped. The window to the outside looked like it had been the target of a large pigeon with diarrhea. The doctor's desk had a glass top, now with pretty white spots. Same adornment for the books in his bookcase.

And as for the doctor himself... Well, he wore glasses for a start, but now he couldn't see much. When the explosion occurred he had obviously opened his mouth in surprise and now he was spitting madly. There was also stuff dribbling down his chin. And his hair, his fine black hair, now sported a massive overdose of Brylcream.

My mother got off clean. She was on the other side of me, gripping the non-targeted arm just in case I decided to swing it at the doctor. She was shielded from the blast by my body. I, of course, was a bit of a mess. But being a small boy, I was used to being a mess anyway. It was my natural state.

When he got his wits back, the doctor pulled the disconnected needle from my arm. And then he wrote out the bill, as soon as he could find some forms that weren't saturated with white goop. When the door opened I made a run for it, remembering that the doctor hadn't successfully administered his shot. Maybe he was planning another go.

But I was out into the carpark quicker than you can say "Hey Tommy, wait a minute". Safe at last. Served the bugger right, it did! Him and his horse needles...

Now, Children of Australia, take note of this adventure. Should the government take the USA example and make injections compulsory for all doctor's visits, you might not find it so profitable to develop a sudden illness to arrange some time off school. My early training in this field has stuck with me for life. I still avoid doctors like the plague, because subconsciously I know that doctors mean shots, and shots aren't fun. Except, of course, when the syringe explodes. That's worth every minute of it!

As for the Lovelace Clinic, it has gone from strength to strength, and now there are branches all over the city of Albuquerque. That means every kid in town is now within easy reach of one. Aren't they lucky! But in all seriousness, the Lovelace Clinic is on the forefront of technology; that's why the astronauts were sent there.

Maybe the Lovelace Clinic will be the first to develop the painless injection... ❖

AN INITIATION INTO ELECTRONICS...

It's easy for those who have been in electronics for a while to forget how difficult it can be for the beginner to 'break through' the initial barriers of technical jargon and arcane concepts. Here's a first-hand account of the problem, from a reader who only recently joined our ranks. Both she and we hope that it will encourage more young people of both sexes to consider electronics as a career. It's clean, it's satisfying — and not as difficult as you expect, once you've mastered the lingo!

by CHRIS SITKA

Electronics is a bit of a mystery to anyone who is not 'in the know'. Indeed the religious mysteries of life have been replaced in modern culture by the esoterics of electronics. Those with the inside knowledge of how circuits function are the mystics of modern civilisation.

Having perceived this truth, I decided to become one of the initiates. That meant undertaking a six-month full time intensive introduction to electronics. Before I started I knew how to change a battery in my transistor and, just to prove that my grasp of electronics was better than average, I'd figured out how to program my video recorder.

Apart from that I was a novice. Yet in a moment of angst, I had taken a look and seen what was in the guts of the monster that now runs the world. It was electronics, it is electronics and it will be electronics.

But what is electronics? I wondered, as I took my new computer and printer to the repair shop for the fourth time in only a few months. I can do an oil change on my car. In fact I can replace the spark plugs and even change the head gasket. Yet I was terrified to lift the bonnet of my computer, lest it instantly explode in sparks. Perhaps I could discover where the computer's bonnet catch was hidden. Besides, I needed a new career.

So I rang up ITEC about their electronics course. I rang and I rang, and eventually got onto the list of 100 hopeful prospects who could participate in the selection process for 20 places.

I would like to say I studied up for the interview, but I didn't even know what to study up. I was still too intimidated to wander around a Dick Smith shop, in case someone asked me what I was looking for. Yet I had read a Dick Smith brochure I'd snatched from the counter the week before, so it can't be said I went in completely ignorant.

The orientation talk was held in the actual workshop room. Glancing around at the array of equipment piled on the bench tops and a room full of eccentric looking zealots, I edged towards the door where Scott bumped into me and asked me to hand out the test papers. Test? Well I'd always liked tests, so I sat down and glanced at mine. Maths. I didn't know electronics was a maths subject. Such was my ignorance.

Well, I must have more of a way with numbers and identifying shapes than I thought, because I passed. Of course it may be that I was one of the few in the room who had not yet learnt to rely on a calculator, the use of which was banned in the test. Sometimes there is advantage to ignorance...

I felt like I was competing for a job rather than a place in a course. Next was the interview. Ralph took me into a small room which contained nothing more than a few electronics components. I didn't know they were *called* components then — a fact that was revealed when Ralph showed me a sample circuit board and asked me if I knew what the various strangely-shaped objects thereupon were.

Cleverly I noticed that some words were written in English amongst the numbers. "I guess those are resistors, because that's what is written on the board next to them," I answered.

He must have been impressed by my initiative, because he went on and got me to screw various sized screws into the right holes. (Maybe this was really a psychology test, to see if you have the right mental attitude to cope with the inevitable frustrations of all the bung circuits to be encountered in the future...)

When asked about my technical capabilities, I told Ralph that I had taken apart and rebuilt a car engine. This was true, but I neglected to mention it still didn't work properly when I got it back together. Still, I don't think he'd ever met a woman who had performed such a curious feat before, so he put me onto the course.

The first day

I turned up on the first day and was allocated a bench of my own. Sitting there in a daze surrounded by CROs, sig gens, power supplies and what have you, my eyes fell on the one recognisable object amongst it all: a funny kind of antenna. I wasn't quite sure what it received from or transmitted to, but at least it was a familiar shape — a lovely spiral. I was soon to be disillusioned when we began our first practical session. The antenna was in fact a stand, to hold my soldering iron.

Having spent my first week mastering the intricacies of soldering, the instructor's faith in my abilities was demonstrated to me when he handed me a kit to assemble. We were to make up our own multimeter, and it was made clear to me that I would be using it every day of the course — so it had to work.

I had never even seen a kit, let alone assembled one. Gingerly I opened

up a packet full of pretty coloured plastic objects, with wires sticking out at various angles. I pulled out the instruction booklet, which told me to start by checking I had all the components listed. Well, I could tell I had the batteries, and various wires, but as to the rest... potentiometers, capacitors? What might they be?

I called the instructor over and he quickly pointed to one after another of the bits and pieces and chanted an incantation. Luckily a rather knowledgeable fellow, who spent his time poking around inside a computer with probes that went beep, was sitting near me. One by one, he told me which bit went in which hole and which way around. I was really good at soldering them in, though.

It worked!

Miracle of miracles, my newly assembled multimeter worked! Now I was ready to become a technician. Though it was to take me quite a while before I actually understood what I could do with a multimeter...

First I had to go to base one: memorising resistor colour codes. One day on my way home I visited a friend and showed her the shoe box lid on which I had assembled the entire E12 range. "Oh, you've taken up beading!" she exclaimed.

For weeks I fell asleep into resistor-colour-coded dreams. During the day I would break out into a cold sweat when I tried to read their resistances on my analog multimeter. Funny as it may seem to you, and even to me now, I couldn't for the life of me work out which range of the display was the one I should be reading. I didn't dare try for voltages, lest I end up with a splodge of melted plastic meter.

The pressure was never off. Once I could twiddle away confidently on my multimeter dial, lo and behold, I was introduced to a monster called a Cathode Ray Oscilloscope. This was nothing less than a terrifying science fiction version of a multimeter.

Dancing lines gyrated across the screen and either changed shape or disappeared whenever I dared to touch the controls. I was supposed to be able to communicate with this gadget, and get those gyrations to dance in step with choral symphonies devised by our high priest.

Author Chris Sitka is now quite at home on the test bench, despite her initial hassles penetrating the mystique of electronics...

Eventually I got the better of it. I could discern even the minor graticules of amplitude and period. Why, I even fed in frequencies from an audio signal generator, and laughed as I calculated the RMS or peak to peak voltage. The devil's chorus was becoming a hymn.

Like a pro

By now I was building up circuits like a pro. I could make buzzers buzz and lights flash, on queue. Varistors, capacitive reactance, signal diodes were all grist to the mill to me. I was an initiate now. I could whip up a Voltage Divider Partially Bypassed Amplifier Circuit and work out the dreaded R_B (Base Resistor) with one hand, while wiring up an Improved Astable Triple Five Timer with the other. Well almost. I certainly knew that a Low Pass Filter was not a basketball tactic.

Probably the most exciting electronics component I ever met was a Jump-Kill flipflop. It certainly impressed my friends, when I told them that I could get the better of a Jump Kill flipflop. I can only hope they realised that I wasn't boasting about stomping on a pair of kiwi thongs.

You see, I had reached the realms of the incomprehensible. Only the inner circle of electronics technicians are able to interpret the specialised lingo of electronics. I was finding that whenever I tried to talk to my friends or family about what I had learned or done that day, their eyes would quickly glaze over as they said "That's nice, dear".

No wonder. This new language I was learning, techo talk, has such wonderfully obscure phrases as *inductive reactance* and *input impedance*. Of course everyone knows what input impedance is! It is so basic. Alas, only to those in the know.

Techo Talk is Ancient Uzbekistani to the average English speaker. I realised

Continued on page 81

If Nimbus Technology has its way, you'll watch

VIDEO FROM YOUR AUDIO CD PLAYER!

Within a year or two at most, we'll be able to watch video programs played back in digital form, from 120mm compact discs. But exactly what format they'll be in is a matter of considerable debate at present. UK-based Nimbus Technology has developed a format which can be played back using many standard audio CD players, using an outboard decoder box, although at present Philips and Sony are not prepared to endorse it — and favour a different format which needs a new type of player...

by LANCE MILNE

Just when you thought everything was going along nicely in the world of standards and compact disc technology, along comes a development that is quite revolutionary and tends to upset the established order.

It is interesting to speculate whether Philips and Sony (co-developers of the CD) ever really dreamt their revolutionary new optical format would become so successful that it would be used to carry not only digitised audio, but data (CD-ROM), interactive still video (CD-I) and eventually full-motion video — for 79 minutes, with stereo sound!

English company Nimbus Technology has demonstrated that they can easily fit 79 minutes of full motion, high quality colour video on a normal CD.

But here's the clever bit: it plays back

on an ordinary audio CD player, provided it has a digital output and you have a special 'black box' decoder, which provides video and stereo sound to your TV and hifi system.

Nimbus has even gone a step or three further and developed a 'double density' disk which plays for over two hours, and is still trackable on some existing audio CD players! (Oh dear, I think I can feel a new standard coming on...)

Before we jump ahead too much, though, lets take a step back for a moment and review the developments so far in CD technology. Then we can see how this new development fits in.

In the late 1970's, Philips and Sony got together to develop a radical new format, then known as DAD (Digital Audio Disc). Philips did most of the optical and laser development, while Sony worked hard on the development of transports, servos and decoding chips which could be mass produced.

In the early 1980's they had a system spec worked out, prototypes demonstrated and then went into production, as well as licensing the rights to various other companies — providing they stuck rigidly to the 'Red Book' standards which describe the physical parameters of the discs and tracks, as well as the exact encoding/decoding of the audio and data allocation of the data stream.

This was a good move, in keeping with Philips' earlier similar commitment to the Compact Cassette, which must be the most successful audio format ever — primarily because any cassette plays on any machine, without any necessary adjustments by the end user. Having standards keeps the cost down also, because many manufacturers have been able to tool up for huge production runs over many years. The same cannot be said for cylinders, 78 and microgroove discs, reel-to-reel tapes or even computer floppy disks.

Thanks to the standards established by Philips and Sony, then, any audio CD plays on any player (the possible exception is the 75mm singles, but even they are playable on an older 120mm-only player by the use of an adaptor ring).

Understandably, Philips is highly reluctant to approve new CD standards, if it potentially threatens compatibility with existing equipment and disks. However new standards have been approved, as new developments and applications became possible: the 'Orange Book' for CD-ROM and the 'Green Book' for CD-i (interactive-CD); however neither of these standards is meant to be applicable to audio CDs and players.

In the meantime, there is somewhere around 30 million or more audio CD players out in the world market, of which about 35% — or 10 million players — have digital ('sp-diff') output sockets.

Nimbus came up with the idea of squeezing a full-motion colour TV picture and sound onto a CD datastream, playable on the above-mentioned 10 million players. But there are a few problems!

Firstly, how do you digitise and fit a full-quality TV picture, with an analog bandwidth of say 5MHz, into a datastream that can only handle around 4Mbps? Let's do some simple maths to illustrate the apparent impossibility of the suggestion.

CD audio has two channels (left and right) with an analog bandwidth of 20kHz. These are sampled at 44,100 times per second (44.1kHz) and each sample has 16 bits of resolution. That's 44.1 x 1000 x 16 = 705,600 bits per second for one channel or around 1.4Mbps for stereo. By the time this goes through the EFM (8-to- 14) modulation and interleaving process, for error concealment with extra data and synchronisation bits added, we end up with a basic bit-rate of around 4Mbps.

Now let's do the same for a TV picture. Assuming a PAL colour signal of 5MHz bandwidth, it is usual to sample at three times the colour subcarrier frequency or around 13.3MHz, for a composite signal. Each sample should be of 8-bit depth, to yield 256 steps of amplitude resolution for reasonable quality. This gives a basic data rate of 106Mbps, before we have even thought about redundancy and error correction!

It's clear that we'd need 150Mbps plus, and that's without adding sound to our pictures!

For a 90-minute movie, this would take a staggering 150 x 60 x 90 = 810,000Mb or 100 gigabytes of storage. Oops! A poor old CD only handles 4Mbps, and has a total storage of around 0.8GB (depending on how you play with the numbers and what allowance you make for error correction), which is therefore about 100 times less than what we need TV.

What is needed is a magic system which digitises a moving TV picture, and then compresses or throws away about 99% of the data, and still leaves a good quality TV picture!

For some years, there has been an enormous research effort into doing just that, and the result is a standard known as MPEG-1. MPEG stands for Moving Pictures Expert Group, and is involved with the ISO (Industry Standards Organisation) in setting new digital TV and audio standards.

It may be interesting to note that high-quality video is becoming more digitally-based by the minute, and newer professional digital video recorders like Panasonic's D-5 machines can read and write vast amounts of data. D-5 machines have the capacity to record a data rate of 300 megabits per second on half-inch tape, and therefore can record super-quality pictures virtually loss-free, without the use of *any* data compression systems!

MPEG-1 video

The MPEG-1 video compression system can really only be fully explained by consenting mathematicians with time to spare, but we'll have a look at the basics of the system. A lot of the comments that follow are valid for other compression systems and devices like standards converters, which convert NTSC pictures to PAL or SECAM and back again, and have to compute what really goes on within frames and lines of a TV picture.

MPEG-1 reduces data rates in three ways, all of which rely on the premise that there is actually a whole lot of information in every TV picture that does not really need to be transmitted. By exploiting the characteristics of the human visual perception, a huge amount of unnoticeable or repetitive information can be thrown away by the encoder.

It is worth noting that this is not *true* data compression like using PKzip or similar on your PC: with true data compression, every bit of the original data can be reconstructed from the compressed files; it's simply 'squeezed up' and then 'unsqueezed' later.

Video compression is more like turning orange juice into concentrate — we just extract the 'essence', the bit that's considered worthwhile, from the original, and ultimately use it make a reasonably acceptable 'reconstituted' product.

The three techniques used in MPEG-1 to achieve bit rate reduction are pixellation, inter-frame coding and intra-frame coding.

Pixellation

In the process of pixellation the original analog picture, made up of lines and frames, is digitally sampled and made into digital values, each one of which represents a little fraction or dot along a TV line — called a pixel. Ob-

viously, the smaller the little sampled areas, the better the resolution — but the larger the number of pixels used.

At this stage, it is not necessary to have vast numbers of pixels for super-quality digital pictures, as it will only confuse the following processes and tend to create excessive bit rates. After all, the object in this case is to produce reasonable quality video in a limited bandwidth.

In the same process, the interlaced scanning of TV would be converted to *progressive scanning*, using a smaller number of lines than TV. The end result of this process is to neatly convert each TV frame into a matrix of pixels, just like a computer-generated image.

The pixels are grouped together as sets of 'blocks', each consisting of a matrix eight pixels horizontally by eight pixels vertically, or 64 pixels per block. Thus the total frame becomes a series of square blocks, each containing 64 pixels.

The above figures are for blocks representing the luminance (monochrome) information; the colour is converted into blocks of only 4x4, which is half the resolution vertically and horizontally compared with the more significant luminance content of the picture. The rest of this article will consider only the luminance blocks, but the concepts apply in a similar manner for the colour information.

Inter-frame compression

The positions of the blocks are used to figure out what is happening between frames for the second technique: inter-frame (between frames) data reduction.

Consider a typical scene in a movie or soapie; there are not many changes from frame to frame, so why retransmit information that repeats over and over every frame? Using the pause control on your VCR and slowly crawling through frames will show just how much information is similar between frames. This is called *temporal redundancy*, and most of the data compression in the overall MPEG system is achieved by taking advantage of it.

The core of the concept is to transmit the information making up the blocks once, and then only transmit update information about which way the blocks are moving. The decoder is then left to reconstruct them in the right place on the screen.

It's really a bit like a jigsaw puzzle, turning the picture into small blocks and describing how they move around — then hopefully getting them into the right places during reconstruction. The other complication is that the blocks themselves change as well!

Rather than transmitting (or storing on CD) the information about the exact location of the blocks, mathematical coefficients related to motion vectors are developed by comparing previous frames with the present and future frames, so a trend can be guess-timated and turned into numbers.

You may wonder about that term 'future frames'. At this stage, really good MPEG coding seems to require lots of careful analysis by the encoder, so it can optimise the maximum amount of information into the data-stream. The best results are obtained by feeding pre-recorded video into the encoder, so it can look both ahead and behind in time, and adjust its encoding accordingly.

In fact the MPEG standard recognises three types of encoded pictures, within its data-stream. 'I-pics' are *intra* pictures, containing only information from the original picture which the system uses as its main reference to lock onto. These are only moderately compressed and contain the greatest amount of information; they may only be sent two or three times a second.

The second type is 'P-pics' or *predicted* pictures, which are more highly compressed due to motion compensation and are coded with reference to the nearest I-pics or other P-pics. Finally there are 'B-pics' or *bi-directional* pictures, which are encoded using both past and future pictures as a reference.

The best quality encoders do an awful lot of number crunching to optimise the information within the limits of the data rate, which probably explains why some encoding companies were charging hundreds of dollars per minute of encoded video.

Intra-frame compression

Having looked at the concepts of pixellation and inter-frame processing of video, to remove temporal redundancy, the third concept to look at is *intra* or 'within the frame' processing, designed to reduce *spatial* redundancy.

This is done by analysing the 8x8 blocks using two techniques: DCT or *discrete-cosine transformation*, and run-length coding.

To introduce the latter concept first, let's take a step back to the good old fax machine for the moment. After all, fax is only a slow-scan television system, using paper readout instead of a CRT.

Those of us who spend time waiting for faxes to go through will probably have noticed that a nearly empty sheet of paper roars through the machine, while a sheet with lots of detail (e.g. photographs) chugs through much more slowly.

That's because the fax machine only sends information on the transitions from white to black — if there's a whole area of empty white space, it simply sends a code indicating the length of 'spaces of white', rather than repeating the same code for white over and over again.

This is the idea of run-length coding, which is in fact true data compression, because the original data can be reconstructed perfectly at the receiving end. Why waste time and bandwidth repeating yourself?

There is a problem with run-length

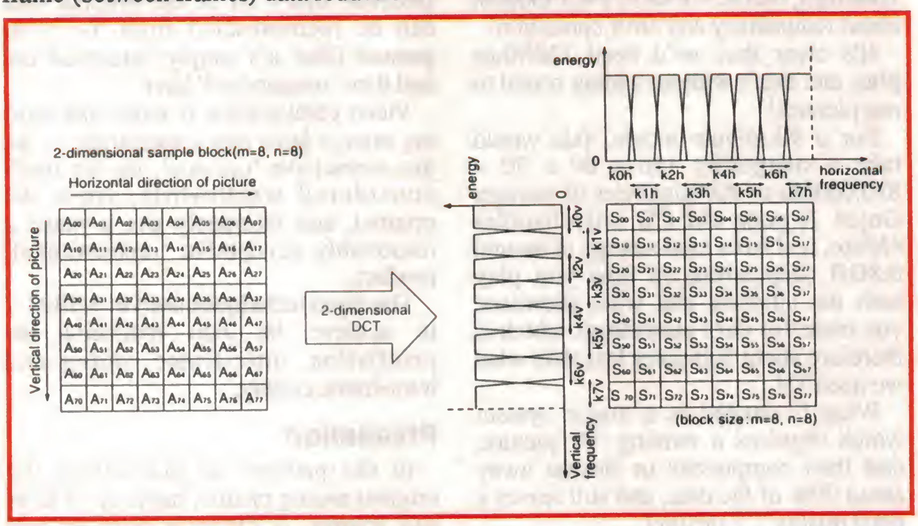


Fig.1: As part of the compression process, an 8 x 8 pixel block (shown here as A00-A77) is transformed into a set of frequency component coefficients (S00-S77), by a process known as discrete cosine transformation (DCT).

coding the digitised video picture, though. Unlike a black-or-white fax transmission, the TV information contains many subtle transitions anywhere along its 256 quantised steps; our little block of 8x8 pixels will have 64 pixels, all with different levels or values.

This almost random distribution of data makes things very difficult for run-length coding to have any worthwhile effect, bearing in mind that run-length coding is the heart of data compression for intra-frame processing, and all the following techniques are employed to make the run-length coding work effectively.

Lowering the entropy

At this stage we have to delve into statistical mathematics, combined with a dash of information theory, and re-arrange the data of our 64-pixel block to allow for any redundancy in the data to be more obviously seen and then dispensed with. This is known as *entropy reduction*. Entropy is concerned with the weighting and distribution of data.

Here's a way of wrapping your thinking gear around that statement: supposing we have an extremely varied society where there was just about equal numbers of very rich people, wealthy, middle class, low income and poor people — but the people concerned were moving from one group into another quite often (heavy stock exchange players, maybe?). This would be a situation of high entropy, and it would be difficult to simply model a mathematical expression for any given person on the above.

High entropy implies little redundancy in the data, which is bad news for run-length coding.

However, if there was another society where the rich stayed filthy rich and everyone else was utterly poor, without any changes, then clearly the income of each person would be very repetitive and easily modelled. This is a state of low entropy data.

The English language has low entropy, which implies high redundancy; in fact English is only 21% efficient for the 26 symbols it uses, meaning that there is a 79% redundancy factor.

Getting back to TV and MPEG: to achieve data compression by run- length coding we need to reduce the entropy of our 8x8 pixel data blocks, thereby making it easy for our run-length coding system. But we've already established that video data is fairly random in nature and therefore has high entropy.

MPEG's method for reducing entropy is the complex process mentioned earlier, known as the *discrete cosine transform* or DCT. This consists basically of three steps.

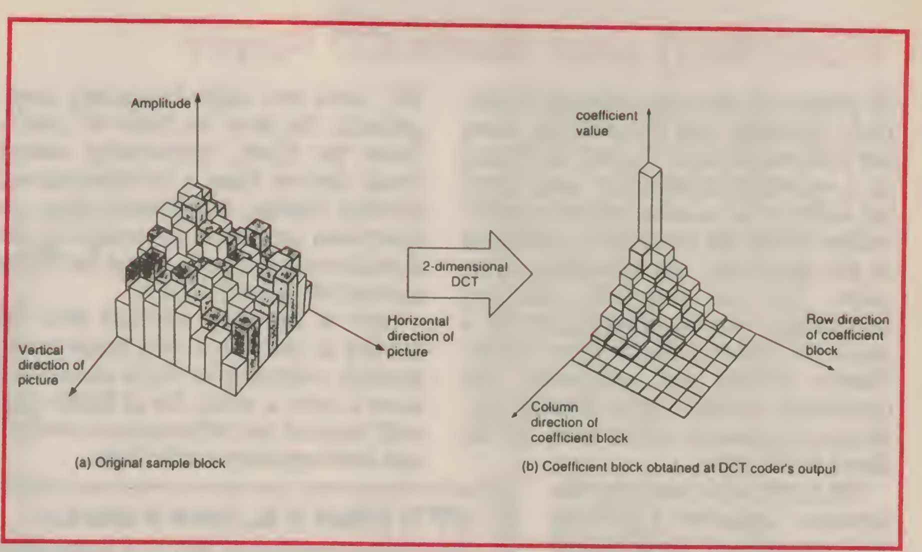


Fig.2: A diagram showing how the DCT transform process reduces the amount of information which needs to be transmitted to convey the image data in each block of pixels. (These diagrams courtesy of Sony.)

The first is to take an average level of the 8x8 block by analysing the data of all 64 pixels. Remember that each pixel in the 8x8 matrix has a value between 0 (black) and 255 (white), representing its brightness. If the 8x8 block is in a darker area of the TV frame, for example, the average value will be low.

Note that the averaging process above is a two-dimensional analysis, because our 8x8 block has both vertical and horizontal pixel data.

At this stage we now have one number between 0-255. This becomes our first, or 'DC' coefficient. It's called DC, because it refers to low-frequency average picture information, which is static for any given block at any moment in time. Interestingly, using just this one coefficient for each block, a whole low definition TV picture could be made.

The picture would look exactly like the 'blockiness' effect that you may have noticed in video effects, and is often seen during news broadcasts to smear out the face of an alleged murderer or similar on their way to meet the judge. That is very coarse pixellation, but in fact contains a great deal of information about the picture and has already massaged to reduce entropy.

Step two in the DCT process involves an old technique used in the digital and analog worlds, known under various names such as *differential coding* or 'delta modulation'. It involves comparing the amplitude value of each of the 64 pixels with the block's average (the DC coefficient) and working out the variation or deviation from the average. In other words, rather than dealing with the absolute value of each pixel, we use the information regarding changes from the average level within the block. This also helps reduce the entropy, as any blocks containing basically similar pixels will produce almost no differential information.

However, the above only helps sometimes. We still need to transform this new differential data into a form of even *lower* entropy.

At this stage in the story, a clever Frenchman steps in to help. Baron Jean Baptiste Joseph Fourier (priest, soldier and mathematician), at 21 years of age, astounded the French Academy in 1779 with his new research into numerical equations. He figured out that any waveshape can be represented by a series of sinewaves, in varying combinations of amplitude and phase, and had the equations to prove it! These are known as Fourier transforms: they transform from the *time* domain into the *frequency* domain.

Herein lies the secret: using mathematical techniques that are cousins to Fourier's, the differential data from step two can be converted from the time domain (amplitude vs. time, like a CRO) into the frequency domain (amplitude vs frequency, like a spectrum analyser).

Once the differential data, representing the changes between the 64 pixels, is viewed in the frequency domain, it becomes apparent that there is a much lower level of entropy and quite a lot of information can be discarded without visibly affecting the picture. This is done by looking at the rate

of change of the steps between pixels, both vertically and horizontally, using the differential data. The rate-of-change of a waveform (computed using good old differential calculus) gives us information about the frequencies contained in the signal that the waveform represents. You may remember that any waveshape can be represented by a series of discrete frequencies (as per Fourier above) and vice-versa. The conversion between time-domain and frequency-domain relies upon all the above information.

Old timers will remember the constant argument regarding AM transmission: do sidebands really exist? You can't see sidebands on a CRO (time-domain) but you can see the carrier jumping up and down in amplitude beautifully. Look at the same signal on a spectrum analyser (frequency domain) and you see a lovely stable carrier and sidebands jumping up and down. It's the same thing in a different form: the variations in carrier amplitude make new frequencies dependant upon the rate of change of the sine-wave carrier.

Techniques similar to the Fast Fourier Transform or 'FFT' (see separate box) are used to convert the data from step two to the frequency domain. Mathematically minded readers will see the significance of the term 'cosine' in DCT, as the result of the differentiation of a sine wave is a cosine. So step three is the time-to-frequency transform, which is pretty complex because it operates over the 64 pieces of data from step two, in two dimensions — remembering that the pixel data represents horizontal and vertical information. Once it is complete, the result is very interesting and is represented in Fig.1.

The 8 x 8 matrix does not represent individual pixels any more. They are now called coefficients, representing the level of energy in bands of frequency components. It's a two- dimensional spectral display. The coefficients closest to the reference DC level (top left) are the levels in the lower frequency components, whereas the ones on the bottom-right hand corner, further from the DC level are high-frequency components. So now we have 64 coefficients per block, representing energy levels derived from a two-dimensional spectral display, transformed from the waveform produced by analysing the deviation of pixel values from the DC or average block level. Whew!

Now it becomes obvious that the entropy of the data is very much lower, because reference to Fig.2 shows that there is now a whole lot of blank data, with most of the information in the DC and low-frequency coefficients.

FFT: What it is, how it works

Fast Fourier Transform or 'FFT' is a catchword that we hear a lot these days, especially in conjunction with DSP (digital signal processing). Analog signals contain amplitude, frequency and phase information: most enthusiasts are aware of the digital *sampling* of analog information, by chopping the incoming signal (which is really an amplitude variation with time) into tiny slices very quickly, to produce a series of voltages at the sampling frequency, and then representing the voltage of each sample by a binary number, say eight or 16 bits long; this is called *quantisation*. Thinking of the incoming waveform as a graph of amplitude-versus-time, then the amplitude axis is represented by the quantisation and the time axis is represented by the progressive samples at regular intervals.

But how does the digital circuitry look at the *frequencies* that are contained in the signal? Obviously, the frequency and phase information is still embedded in the sampled signal, as the sampled signal is still a faithful replica of the original signal. What is needed is a kind of digital spectrum analyser! This is where Fourier transforms change from the time-domain into the frequency-domain.

Let's look at an example of how this is done. Supposing we sample an audio signal at 48kHz. The highest frequency that we can pass through the system is half the sampling frequency, or 24kHz, in accordance with Nyquist's Theorem. So we put in a nice low-pass filter to chop off the input signal a little before 24kHz. Then the resulting time-domain samples are mathematically processed using Fourier analysis.

The amazing thing is that the FFT conversion gives a spectrum with exactly half as many frequency samples as there were time samples (Nyquist again). In our case that's 24,000 frequency points per second. If we took a chunk of these samples covering just 10ms, we would have 240 frequency points over a spectrum from the highest frequency (two complete samples) of 24kHz to the lowest frequency — which is the period of 10ms, or 100Hz. Thus we have a neat little series of frequency samples, every 100Hz from DC to 24kHz. Anything below 100Hz is considered to be DC in this example.

The advantage of FFT conversion over the traditional analog spectrum analyser is pure speed. In our example, we developed 240 frequency 'data bins' simultaneously in 10 milliseconds. With sampling frequencies in the 10-100MHz range, an entire video spectrum can be analysed and processed thousands of times per second!

We are finally ready to efficiently run-length code the data. Due to the fact that at least half the co-efficients are now insignificant, the run-length coding can call them all zeros, and the amount of quantising steps of some of the other data can be reduced with very little visible effect.

Suddenly we have a useful compression ratio. Run-length coding now occurs, by scanning the new 8x8 coefficient block in a zig- zag pattern — starting with the DC coefficient and working towards the lower right. High efficiency look-up codes are used to represent the run-length coded data.

How many coefficients?

I have seen a display of just how many coefficients are needed to produce an acceptable picture. Obviously the coefficient information contains all the detail information in the picture, and the decoder uses the data to fill in the detail within the blocks. Good pictures can be produced with as few as nine coefficients!

The run-length coder has a buffer and feedback loop, so it can squeeze as much information into the 1.5Mbps data stream as possible. On fast moving pictures, much of the detail can be lost, but the eye is not very sensitive to this. On fixed pictures, more of the data stream is available to send detail information.

The video run-length coded data stream is combined with the MPEG audio stream and ancillary data (the audio system is broadly similar in its compression to DCC and MD techniques), and this becomes the information impressed on to the disc after suitable processing.

It should be noted that the Nimbus system provides a compatible data stream on CD, playable on an ordinary audio CD player (with the exception of the *flag* signal, detailed in remarks to follow). A combined group of large companies like Philips, Panasonic and JVC is also proposing a very similar standard, but one which is not directly playable on audio-CD players. It has been reported that some of the above group have signed deals with major movie companies for distribution arrangements on CD video.

The 'flag' problem

The next problem is to make the information readable and acceptable to a standard audio CD player, which is expecting to recover audio data: it has no idea that there may be a video 'black box' hanging off its digital output connector.

There is a nasty snag related to the CD 'Red Book' standard, in that any

non-audio CD must have a 'flag' in the control codes either at the start of the disc in the TOC (Table of Contents) area, or continuously embedded as the disc runs. This switches off the CD player's internals, and in many cases stops any data from appearing at the digital output in audio-only machines.

This point is currently highly controversial: Nimbus say that Philips (controller of the CD standards) should alter the Red Book to allow video CDs to play on audio-only players (by dropping the requirement for the flag code), which would allow compatibility with 10 million existing CD players and ensure very fast acceptance of the medium. However the downside is that video CDs (without the flag signal) played on a audio player would produce a horrible high-level trash signal out of the audio sockets, which may destroy speakers and annoy consumers!

Philips apparently say that they do not want to alter the Red Book, and instead have produced a new 'White Book' standard which allows special codes to identify new video CDs. But this means that consumers have to buy new expensive CD-i or similar (karaoke-type) players at perhaps $1000 each — instead of the Nimbus system, which is simply a $200 box which plugs into their audio CD players, and then into their TV set.

So currently, once again we have a classic example of the chicken-and-egg situation; consumers will not purchase a new format if it is expensive and non-compatible, unless there are tangible quality or convenience considerations. Analog laser discs are probably an example of this.

Will the appeal of Philips' interactive system mean it is accepted, or is the Nimbus system more clever as it can make use of so many audio CD player 'platforms' already in use?

An interesting point is that video rental companies would love compatible CD video, if it was universally accepted like audio CD. Pirating would be almost non-existent (CD to CD) and the rented CDs would last longer and maintain condition better than VHS or Beta tapes.

I've also heard that Nimbus are working on even more developments for their Video-on-CD system, including possibly quad-density recording (their special CD mastering plants are already capable of double-density, using special techniques developed in house) and new higher-performance devices. The future will be interesting indeed! ❖

NEW BOOKS

Soldering update

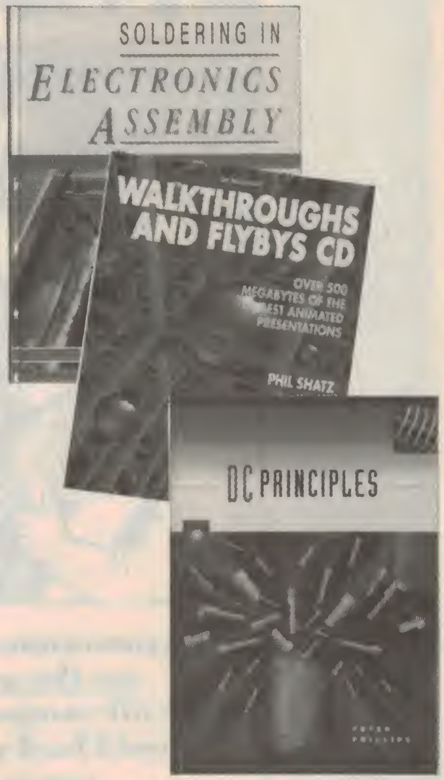
SOLDERING IN ELECTRONICS ASSEMBLY, by Mike Judd & Keith Brindley. Published by Newnes, 1992. Hard cover, 250 x 190mm, 286 pages. ISBN 0-7506-0589-8. Recommended retail price $125.00.

As the authors point out, soldering, as a step in electronics assembly, is straightforward and simple. However, components are changing — with surface mount devices becoming smaller and with more leads, and leadless components gradually replacing through-hole assembly. PC boards are also becoming smaller, with narrower connecting tracks and components more closely spaced. The aim of this book is to show the response of soldering technology to the demands imposed by this evolution.

The content of the book covers the nature of the soldering process, electronic assembly methods, and the properties of solder and flux. CS soldering (where the components are all placed before the soldering process), plus SC (vice versa), are treated and compared. There are also chapters on cleaning soldered assemblies (including environmental considerations); avoiding soldering quality problems; and standards and specifications.

Despite treating all the above areas in great detail, the book is easy to read and understand, and is very well illustrated with diagrams and photos. A very useful book for those with an interest in this specialised area.

The review copy came from Butterworth-Heinemann, 271-273 Lane Cove Road, North Ryde 2113. It should be available from technical and larger bookshops.



PC graphics demo

WALKTHROUGHS AND FLYBYS CD, by Phil Shatz. Published by the Waite Group, 1993. Soft covers, 228 x 178mm, 148 pages plus CD-ROM disc. ISBN 0-18-783926-3. Recommended retail price $59.95.

This is one of those book-plus-disc combinations that are becoming more and more common in the computer area — except that in this case, it's not so much a book with a disc illustrating some of the concepts, as a software CD-ROM with an accompanying user manual. And the software on the CD-ROM is fascinating — a real eye-opener!

There's basically some 540MB of (largely 3-D) animated graphics demos for the PC, written by 33 different artists and groups using a variety of software packages including Autodesk Animator, GRASP, 3-D Studio, Fractint, Virtual Reality Studio and Vistapro. They'll all run on a 386 or better machine, with a multimedia- compatible CD-ROM drive and ideally an SVGA graphics card, colour monitor and Soundblaster-compatible sound card. (In fact a Soundblaster is essential for some of the demos.)

If you want a fascinating insight into the things that are happening in PC graphics and animation, I can warmly recommend it. Looking through the demos takes literally hours, and they're a tribute to both the potential of the new authoring software packages, and the creativity of the various authors concerned. I especially enjoyed David Neilson's 'Robotruck' commercial, Michael Mulholland's animated chess game and Ingo Neumann's mercury balls bouncing on a checkboard plane...

A handy feature is that the book gives full address and contact details for all of the authors.

The review copy came from distributors Woodslane, of Unit 8, 101 Darley Street, Mona Vale 2103. However I've seen copies in larger bookstores. (J.R.)

Basic DC theory

DC PRINCIPLES, by Peter Phillips. Published by Thomas Nelson, 1994. Soft cover, 255 x 180mm, 137 pages. ISBN 0-17- 008930-4. Recommended retail price $14.95.

Another book by *EA*'s own Peter Phillips, who is also Senior Head Teacher of the Electronic Trades section of the Sydney Institute of Technology. His nearly 20 years of teaching experience show through clearly in its presentation.

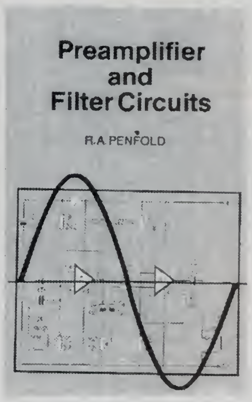
The second of a series, which started with *Electrical Fundamentals*, this new volume is aimed at those studying an electrical or electronics trade course, or anyone interested in learning about basic theory. Its content covers a familiar but important area: electrical power, series and parallel circuits, electromagnetism and electromagnetic induction, capacitance and time constants.

I found the presentation to be particularly pleasing. Written in plain English, its explanations are made in everyday speech, and are very generously illustrated. There are many worked examples in applying the theory, as well as mathematical problems. Included in these problems are situations derived from real life experience, to make things more interesting; for example, the reproductions of manufacturers' labels giving the power ratings of common appliances.

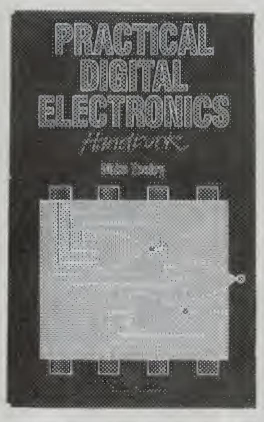
I feel that any student could easily work his or her way through this basic DC theory book, without extra assistance. This makes it an excellent introduction to DC principles, as well as a very useful summary or revision course.

The review copy came from the author. It is available from technical bookshops or from the publisher, Thomas Nelson, 102 Dodds Street, South Melbourne 3205. (P.M.)

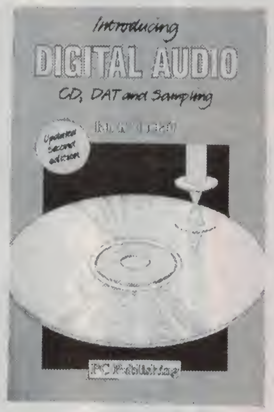
Electronics Australia BOOKSHOP



Preamplifier and Filter Circuits
This book provides circuits and background information for a range of preamplifiers, plus time controls, filters and mixers. The circuits described are simple and previous experience of electronic project construction is not needed.
CODE: BP 3090 PRICE: $11.00

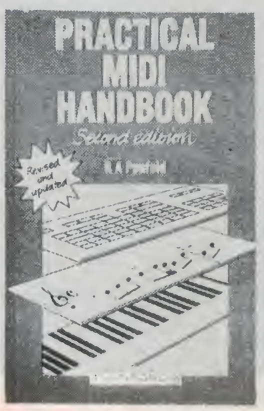


Practical Digitial Electronics Handbook
This book introduces digital circuits, logic gates, bistables and timers as well as microprocessers, memory and input/output devices. It will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry.
CODE: PC 1004 PRICE: $22.95

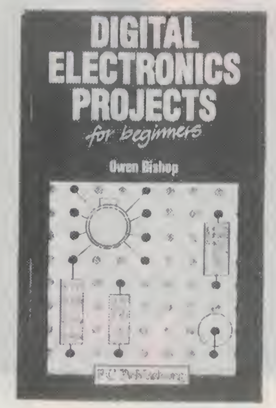


Introducing Digital Audio, CD, Dat and Sampling. - Second Edition:
This book bridges the gap for the technician and enthusiasts who have worked with audio circuits. It includes oversampling methods and bitstream techniques and technical terms.
CODE: PC 1007 PRICE: $22.95

Computers and Music - An Introduction:
This book explains how to simply set up your own computer music studio. It covers the basics of computing, running applications programs, wiring up a MIDI system plus everything about hardware and the programs.
CODE: PC 1006 PRICE: $27.95



Practical MIDI Handbook
Refers to the powerful capabilities of MIDI and how to exploit it, with no knowledge of electronics or computing. It reviews the latest developments in MIDI covering keyboards, drum machines, sequences, mixers, guitars etc.
CODE: PC 1002 PRICE: $22.95



Digital Electronic Projects for beginners
This book provides simple, yet detailed instruction on practical projects. Covering instrumentation to home security plus circuit diagrams, this reference book also offers 'fun' projects for newcomers to electronic construction.
CODE: PC 1011 PRICE: $19.95

HOW TO ORDER

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Big success for NASA — at last...

HUBBLE REPAIR: MISSION ACCOMPLISHED!

As promised, here's a more detailed report on NASA's STS 61 shuttle mission of December last, when a team of highly trained and experienced astronauts carried out in-orbit repairs on the ailing Hubble Space Telescope. The repairs seem to have been a complete success, with the telescope now sporting not only the COSTAR corrective optics for its primary mirror fault, but also a pair of new solar power arrays, new gyroscopes, a new wide-field planetary camera and even a more powerful control computer.

by KATE DOOLAN

By all accounts 1993 was not the greatest year for the USA's National Aeronautics and Space Administration (NASA). The very expensive and highly publicised *Mars Observer* spacecraft fell silent as it reached it destination, and soon after two expensive Earth observation satellites failed. To further compound their woes, NASA was having difficulty in selling their programs to a sceptical Congress — especially the much maligned *Space Station Freedom*, which survived several close votes to have its funding cut. The media and other space analysts were openly predicting the demise of NASA, or a much reduced role in the US space program.

This situation added more drama to the upcoming flight of STS 61, in which the crew would participate in the First Hubble Space Telescope Servicing Mission. With NASA's future on the line, it was essential that this flight be a resounding success; as a result, the flight was 'micro managed' by NASA administrator Dan Goldin, who appointed several review committees and personally oversaw arrangements for the flight.

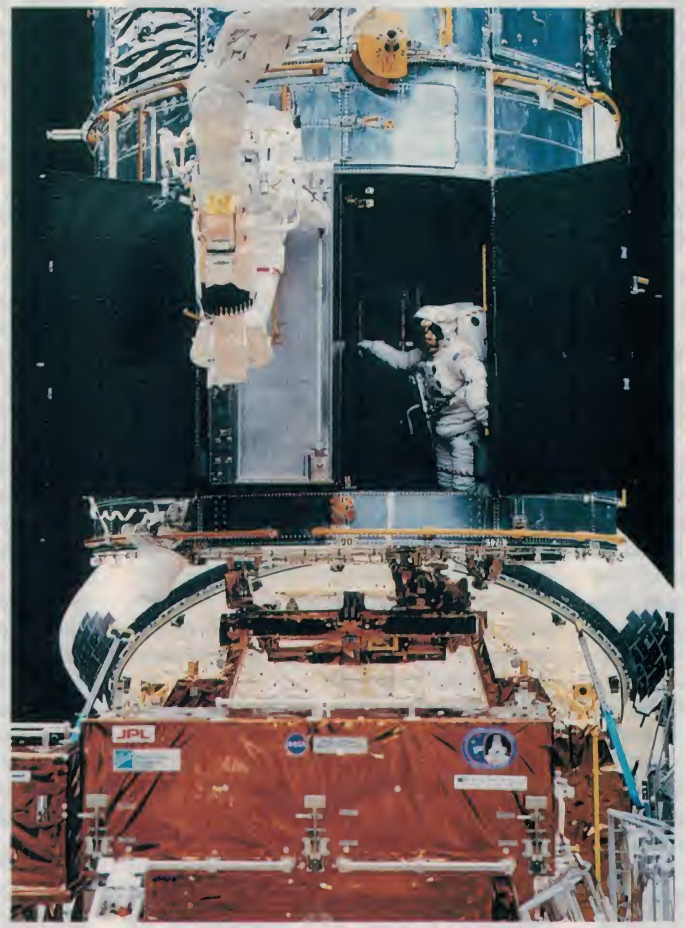
The Hubble Space Telescope (HST) was successfully deployed in 1990 but less than two months later, NASA announced that a manufacturing flaw had affected its primary mirror — giving the HST an advanced case of myopia. Just before the launch of STS 61, the Department of Justice announced that it had dropped all potential lawsuits against the manufacturer Perkin-Elmer (now Hughes Danbury Optical Systems), for a payment of US$25 million.

The Dream Team

The seven STS 61 astronauts, who were nicknamed 'The Dream Team', were possibly the best astronauts that NASA could have selected for the flight. Commanded by veteran Dick Covey, all had flown at least once and Payload Commander Story Musgrave was to be making his fifth flight. Even by astronaut standards, Musgrave is an over-achiever, with seven different masters degrees; he also has over 17,000 hours of flight time. The other crew members — pilot Ken Bowersox, Mission Specialists Tom Akers, Jeff Hoffman and Kathy Thornton, and European Space Agency astronaut Claude Nicollier — had all flown in space at least once and all had been extensively trained for this flight. In case of emergency, they had also been cross-trained so they could do any task required. In fact, the crew were probably the best trained team that NASA have ever sent into orbit.

The launch of the space shuttle *Endeavour* was scheduled for 4:57am (local time) on December 1, 1993. Nine minutes before launch, the countdown was put on hold as there were some minor weather concerns. Chief Astronaut Robert ('Hoot') Gibson, flying over the Kennedy Space Centre, Florida in the Shuttle Training Aircraft, reported that there were crosswinds over the Shuttle Landing Facility, with velocities from 2-6kph over the official shuttle launch constraints. At the same time, an unidentified ship wandered into the restricted area of the Atlantic Ocean where the solid rocket boosters would splash down after they had been separated from the space shuttle.

'Hoot' Gibson kept reporting back to shuttle mission managers about the crosswinds, which had increased in speed. On his advice the countdown was cancelled and the launch postponed for 24 hours.



Astronaut Thomas Akers manoeuvres inside the bay which will house the COSTAR while assisting astronaut Kathryn Thornton with the installation of the 640-pound instrument.

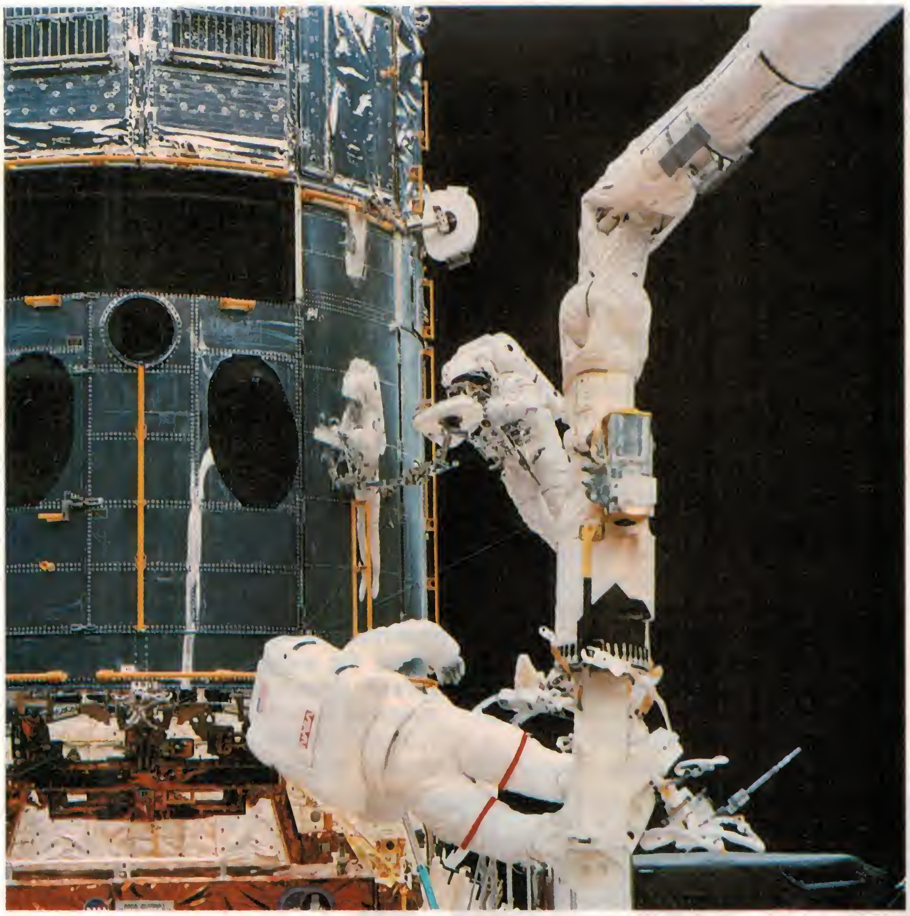
Spectacular launch

The following morning, there were no weather problems and *Endeavour* was launched from Pad 39B at the Kennedy Space Centre at 4:27am. The launch was very spectacular and lit up the night sky for thousands of miles in every direction. After a short eight-minute flight, the space shuttle was in an orbit of 677 kilometres. The crew then checked out the payload bay and the shuttle's systems, in preparation for the five Extra Vehicular Activities (EVA's or 'spacewalks') which were scheduled for the flight.

Kathy Thornton took time out to wish her eight-year-old daughter Laura a happy birthday, and told her about the 'candles' which were lit for the occasion — the solid rocket boosters!

One new 'experiment' which was on board *Endeavour* was a receiver for the Global Positioning System (GPS). This experiment demonstrated the performance

Hubble repair: Mission Accomplished!



Anchored at the end of Endeavour's RMS arm, astronaut Jeffrey Hoffman (foreground) prepares to install the new WF/PC2 into the empty cavity (top left) on the Hubble Space Telescope. Astronaut Story Musgrave works with a PFR at centre, and his image is reflected in the shiny surface of the telescope.

and operation of GPS during the launch, the flight, re-entry and landing phases, using a modified military GPS receiver processor and existing orbiter GPS antennae. The GPS estimated the position, velocity, measurements and attitude data during ascent and entry phases.

When the crew woke up on the second day of the flight, *Endeavour* was 5500 kilometres behind the Hubble Space Telescope and closing in on it at a speed of 462km per orbit. Each member of the crew who were to make the spacewalks — Tom Akers, Jeff Hoffman, Story Musgrave and Kathy Thornton — checked out the life support, power and communications systems of their spacesuits. Claude Nicollier gave the remote manipulator system ('RMS') arm a thorough workout and used its television camera to check the servicing equipment for the HST, in the payload bay. The crew also reduced the pressure in the orbiter's cabin atmosphere from 101.3 kilopascals (normal atmospheric) down to 70.3kPa, to reduce the amount of time that the astronauts would have to breathe pure oxygen before making their spacewalks.

At the same time, the HST's Wide Field/Planetary Camera (WF/PC1) and High Speed Photometer (HSP) completed their last observations of the solar system before the telescope's aperture door was closed. Ground controllers at the Space Telescope Operations Control Centre (STOCC) at the Goddard Space Flight Centre in Greenbelt, Maryland then sent commands to the HST to move into its proper solar inertial attitude for the following day's rendezvous with *Endeavour*.

Before the crew went to sleep that evening, Dick Covey completed two orbiter manoeuvring burns to move *Endeavour* closer to the telescope.

On flight day three, *Endeavour* started the day in a 697 x 666km high orbit and was 418km behind the HST, with the shuttle closing in on it at 132km per orbit. The first of three 'reaction control' burns scheduled for that day changed the shuttle's velocity by 1.5 metres per second, which adjusted the high point of *Endeavour*'s orbit and fine-tuned its course to a point some 85 kilometres behind Hubble.

The second burn, which was an 'orbital manoeuvring system burn', changed *Endeavour*'s velocity by 4.1m/s and adjusted the shuttle's catch-up rate to 36km per orbit and put it only 17km behind the HST. The third and last burn — a 'multi-axis terminal burn' — placed *Endeavour* on an intercept course with the HST, and enabled Dick Covey to take manual control for the final stages of the rendezvous.

A laser ranging and range rate measurement device was used to provide the crew with accurate range and closing rate data for the rendezvous with the HST. The handheld laser devices provided this information despite the fact that the HST does not have a laser reflector.

'Firm handshake'

As *Endeavour* closed in on the HST, Dick Covey manoeuvred the shuttle to within 10 metres of the telescope when Claude Nicollier, using the RMS arm, successfully 'grappled' the HST. This was done while the two were flying over eastern Australia. In announcing success, Covey radioed Mission Control at the Johnson Space Centre: "Houston, *Endeavour* has a firm handshake with Mr Hubble's telescope".

When *Endeavour* captured the HST, it had been in orbit for three and a half years, had made 19,595 orbits of the Earth and had travelled over a billion kilometres.

Once Claude Nicollier had grappled the HST, he carefully placed in onto the Fixed Servicing Structure (FSS) in the shuttle's payload bay, where it would remain for the next five days. Then Nicollier, using the RMS arm's television camera and the rest of the crew using handheld cameras began a comprehensive visual survey of the HST.

During the survey, a kink was discovered in the outer bi-stem of the right solar array. After review by the ground control staff, it was decided to follow the flight plan and retract the arrays at the end of the first spacewalk.

Before the first spacewalk, ground controllers at the STOCC prepared the Hubble for servicing by powering down its rate sensor units two and three, and disabling their heaters. They then turned off elements of the HST which were powered through fuse plugs due to be replaced. As well, the STOCC staff began a 73-minute retraction of the solar arrays; but the right solar array did not budge, so it was decided that it would be manually removed on the second spacewalk.

The EVAs begin

The first spacewalk took place on flight day four, when astronauts Story Musgrave and Jeff Hoffman started their activities an hour earlier than scheduled. After suiting up, leaving the airlock and floating into

the payload bay, the two astronauts installed protective covers on the aft low-gain antenna and exposed voltage bearing connector covers.

The main activity of the first spacewalk was to change three 'rate sensing units' (RSUs), which were pairs of gyroscopes needed to point and track the HST. After three years in orbit, three of the Hubble's six gyroscopes had failed. The astronauts also changed eight fuse plugs which protect the telescope's electrical circuits.

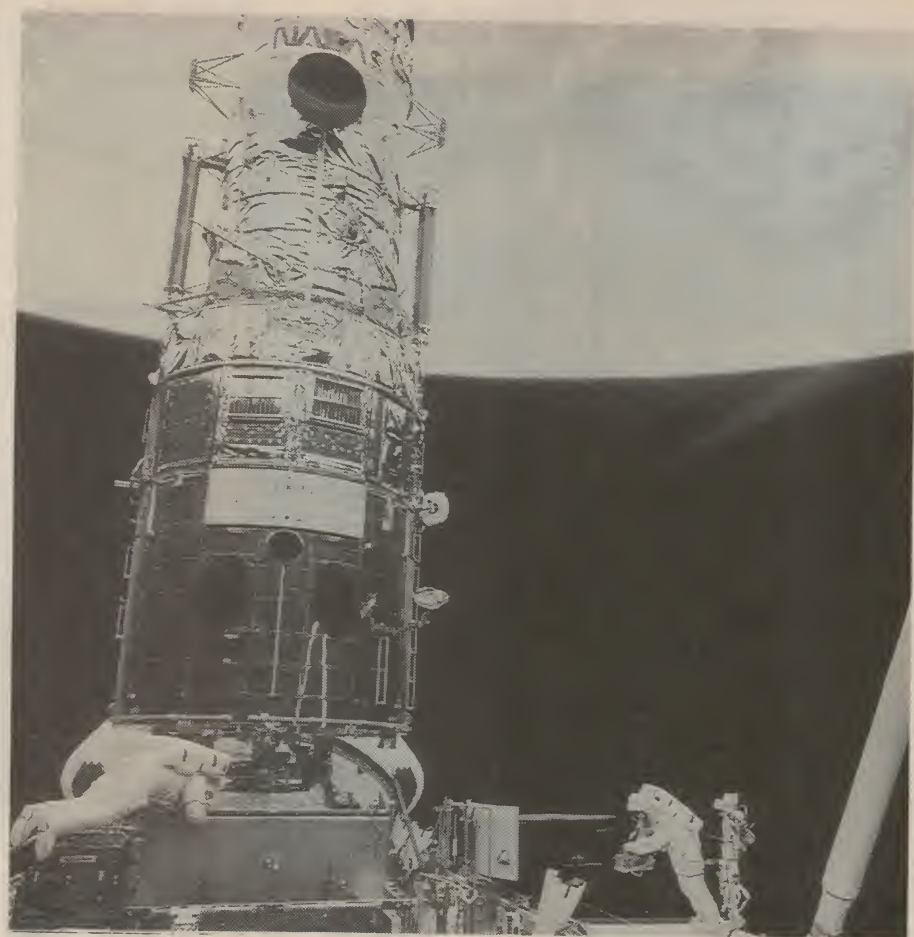
Once the gyroscopes had been installed, Musgrave and Hoffman had difficulty in closing the doors of the gyroscope housing. Ground controllers thought that temperature changes might have caused the doors to contract and expand enough to keep them from closing. After suggestions from the ground, Musgrave anchored himself on a foot restraint at the bottom of the doors and Hoffman was attached to the RMS arm at the top. After simultaneously latching the top and bottom of the doors the two astronauts were then able to shut them.

In preparation for the installation of the solar arrays the following day, Musgrave and Hoffman then prepared the solar array carrier in the payload bay, as well as attaching a foot restraint to assist the astronauts in installing the panels. After being outside for seven hours and 54 minutes, the astronauts had made the second longest spacewalk in NASA's history. (The longest, of eight hours and 29 minutes, was on STS 49 in May 1992 when an INTELSAT satellite was captured and repaired.)

The second spacewalk took place the following day, when Kathy Thornton and Tom Akers began to make preparations for the removal of the right-hand solar array which had failed to retract the day before. Akers disconnected the array from the main body of the telescope and the electrical connections were broken whilst the shuttle was in darkness and the solar array's photovoltaic cells were not producing electricity.

Claude Nicollier then transported Thornton, who was holding the array and attached to the end of the RMS arm, to seven and a half metres over the payload bay — where she released the array into orbit. Dick Covey and Ken Bowersox then manoeuvred the shuttle away from the drifting array, which was moving away from *Endeavour* at a rate of 1.5 kilometres per second. It is expected that the array will re-enter the Earth's atmosphere by December 1994.

Thornton then used a handle to lift one of the new arrays from its storage area, moving it into position on the telescope where it was installed. Akers and Thornton then manually folded the other old array and placed it into the payload bay, where it was returned to Earth for further study. The two astronauts then completed the installation of the two new solar arrays and moments later, STOCC controllers confirmed that both arrays were electrically alive.



Astronaut Jeffrey Hoffman, anchored on the end of the RMS arm, is pictured with the WF/PC1 during the third of five STS-61 space walks, while astronaut F.Story Musgrave is seen near the stowage area for the WF/PC (left).

After a spacewalk of six hours and 30 minutes, the two astronauts returned inside the shuttle. Kathy Thornton complained of ear problems, so the airlock was pressurised slowly until it reached the 70.3kPa requirement.

Next day the third spacewalk was successfully completed when Story Musgrave and Jeff Hoffman installed the Wide Field/Planetary Camera 2 (WF/PC2) and replaced two magnetometers. For this spacewalk, Musgrave was anchored to a portable foot restraint near the WF/PC opening on the HST and Hoffman was on a foot restraint mounted on the RMS arm. Claude Nicollier then used the RMS arm to manoeuvre Hoffman into a position to grasp the original Wide Field/Planetary Camera, which was to be replaced.

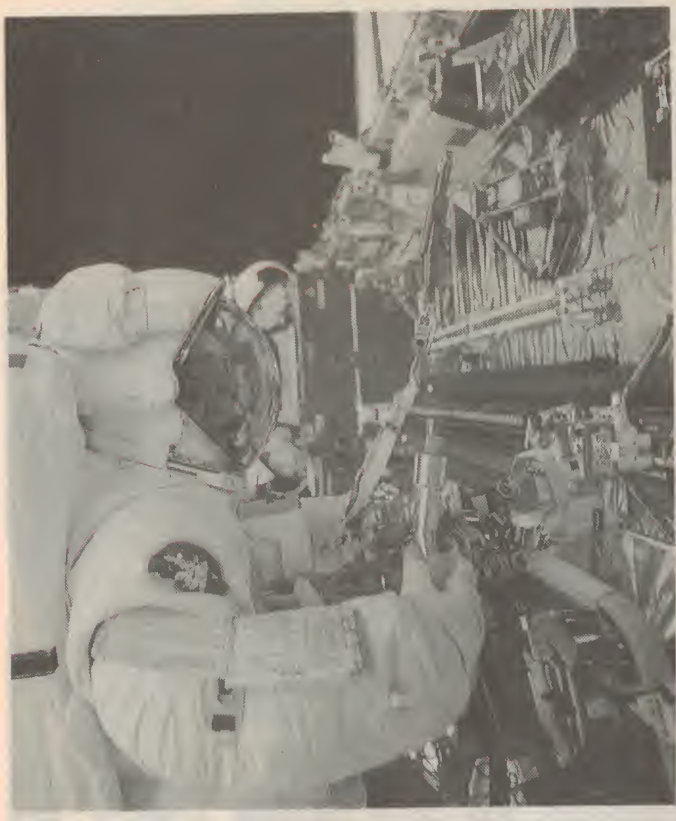
With assistance from Musgrave, Hoffman slowly pulled the WF/PC1 out along its guide rails and paused to allow Nicollier to reposition the arm. Before the WF/PC1 was completely removed, the three astronauts conducted a practice session to prepare for the installation of WF/PC2. Hoffman then placed the old camera into a temporary storage area, whilst Musgrave examined the WF/PC opening and made preparations for the installation of the new camera.

The two astronauts then attached a handle bar to the new camera and pulled it out of its container. Musgrave removed a protective mirror cover and then both astronauts carefully aligned the new camera onto the guide rails and slid it into the HST.

Ground controllers then began to conduct a 'signs of life' test on the new WF/PC2. A science data dump test recovered images from functional tests for processing by the WF/PC Instrument Development Team, and the results were said to be excellent.

The original Wide Field/Planetary Camera experienced focusing problems after the Hubble Space Telescope was deployed in April 1990. These problems were caused by a manufacturing flaw in the telescope's 2.4-metre primary mirror, and as a result blurred photographs occurred. The new camera has four small precisely ground mirrors which will

Hubble repair: Mission Accomplished!



Astronaut Kathy Thornton works with equipment associated with servicing chores on the Hubble Space Telescope during the fourth space walk on the eleven day STS-61 mission.

remove the blur by focusing the stray light of the telescope's primary reflector.

The HST was then tilted forward on the Fixed Servicing Structure, so the RMS arm could reach the top of the Hubble where the magnetometers were located. Once the astronauts installed the first magnetometer, STOCC controllers conducted functional tests and after these tests were successfully completed, the second magnetometer was installed. Following this, the astronauts returned into the orbiter after a spacewalk of six hours and 47 minutes.

Installing COSTAR

The next spacewalk was possibly the most important of the flight, with Kathy Thornton and Tom Akers set to install the Corrective Optics Space Telescope Axial Replacement (COSTAR) unit which would rid HST of its myopia. On this fourth spacewalk, a computer coprocessor would also be installed.

Controllers at the Space Telescope Operations Control Centre turned off the power to the High Speed Photometer. Kathy Thornton, on the end of the RMS arm, then opened the access door latches with a power ratchet tool. Tom Akers then climbed inside the compartment and disconnected the HSP before he helped Thornton remove it along the guide rails. Thornton then grasped the HSP by its handles, while Claude Nicollier manoeuvred both her and the instrument out of the compartment into a temporary storage area on the side of the shuttle payload bay.

Thornton was then manoeuvred above the COSTAR storage area so she could grasp its handles and with assistance from Nicollier, she pulled COSTAR out and positioned it in front of the HST access door. Akers then re-entered the instrument compartment and aligned COSTAR with the HSP guide rails, allowing the two astronauts to insert COSTAR into its new home. Akers then tightened the fasteners and re-attached the electrical cables.

The next task was to install a 386 coprocessor, which would increase both the speed and memory capacity of the HST's main computer. The telescope was rotated on the Fixed Servicing Structure whilst ground controllers turned off the flight computer. This time, Akers was stationed on the end of the RMS arm and he opened the doors to the enclosure which housed the computer.

Thornton carried the coprocessor from its storage compartment over to Akers, where he removed the existing flight computer's handles. Thornton installed these on the coprocessor, mounted it in turn to the original handle mounting holes with four bolts, and made the electrical connections. The two astronauts then collected some aluminised kapton and dacron mesh multilayer insulation for placement around the magnetometers, after it was noticed that the shell had loosened.

After a six and a half hour spacewalk, Thornton and Akers returned inside, where Mission Control congratulated Tom

Kathy Thornton (centre) and Thomas Akers (bottom right) are photographed by one of their crewmates from inside the shirtsleeve environment of the Space Shuttle Endeavour, while performing servicing tasks on the Hubble Space Telescope.

Akers for having more spacewalk time than any other astronaut. Akers' total of 29 hours and 40 minutes broke the record of 24 hours and 12 minutes held by Gene Cernan since December 1972.

COSTAR passed its functional tests shortly after it had been installed, but one problem cropped up. STOCC controllers reported a loss of data lock on the downlink telemetry from the HST's flight computer. It was determined that the data glitch was due to the incorrect pointing of *Endeavour*'s Ku-band antenna at the Tracking and Data Relay Satellite System (TDRSS), which resulted in interruptions in the telemetry and communications between the Hubble Space Telescope and Goddard Space Flight Centre.

Final walk

The final spacewalk was made by Story Musgrave and Jeff Hoffman on the eighth day of the flight. The two astronauts replaced the Solar Array Drive Electronics (SADE), which controls the array's ability to point towards the Sun and generate electricity to power the telescope. Soon after that, Musgrave gently pushed each of the solar arrays, giving them what they needed to unfurl the solar array's 'primary deployment mechanism' or PDM — which had got stuck earlier in the day.

Following that, the two astronauts installed the Goddard High Resolution Spectrograph Redundancy Kit. They then moved to the top of the telescope, where they installed two mylar covers over the original magnetometers — to prevent any contamination from debris that may fly off instruments, and also to protect them from ultraviolet degradation.

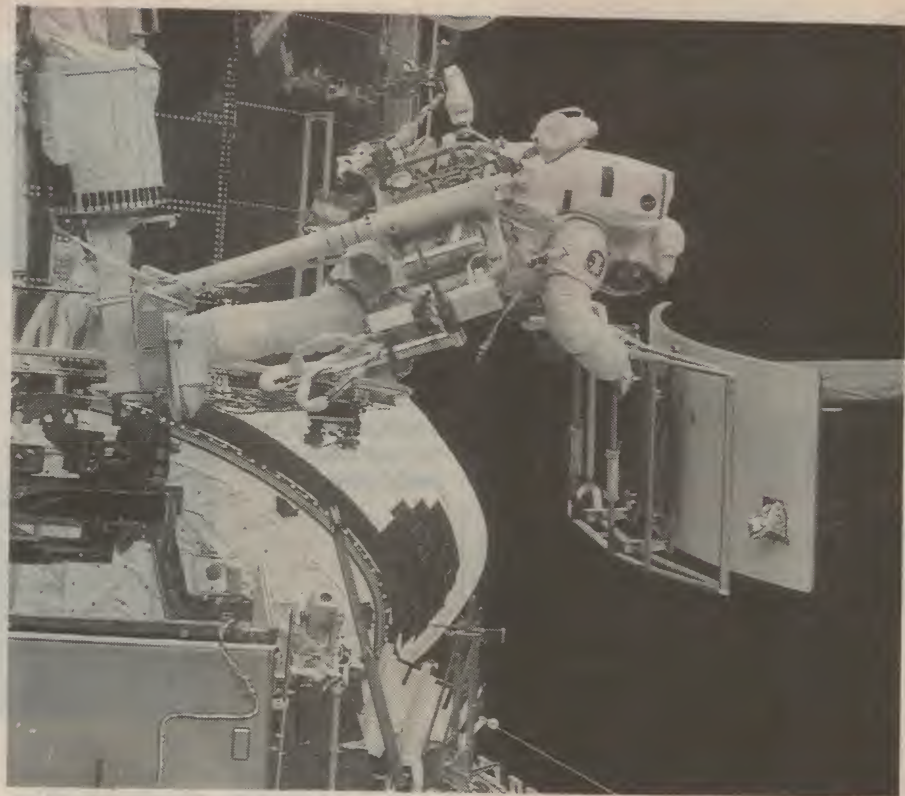
Whilst the astronauts were still outside, the solar arrays were deployed and both were operating perfectly moments after deployment. One of the arrays was slightly twisted, but that was expected and attributed to manufacturing tolerances and residual stress (which eased after the HST completed several orbits).

Musgrave and Hoffman completed the spacewalk after seven hours and 31 minutes, bringing the EVA total on STS 61 to 35 hours and 25 minutes, more than on any other American space flight.

Release delayed

Release of the Hubble Space Telescope the following day was delayed, due to a couple of last minute hitches. Eventually the deployment occurred three and a half hours late due to erratic data telemetry from an HST subsystem monitor. One of four Data Interface Units (DIU), which monitor HST telemetry and commands some telescope functions, experienced dropouts and conflicting readings.

Each DIU has two-sided redundancy, and controllers at the Space Telescope Operations Control Centre found data errors occurring only in Side A of DIU-2; but there were no problems with command capability.



Astronaut Jeffrey Hoffman with the Wide Field/Planetary Camera during changeout operations. WF/PC2 has already been installed.

Controllers switched the DIU to its Side B function with full command and telemetry capabilities, and Side A will be used as a backup system with only a small degradation in its capabilities. The HST has had this problem for several years and it was not related to any work carried out by the STS 61 crew.

Forty five minutes prior to deployment, the aperture door of the telescope was opened and then Claude Nicollier sent commands to the berthing latches on the end effector of the RMS arm to release the Hubble Space Telescope into free flight. Following the deployment, Dick Covey and Ken Bowersox performed two small separation burn manoeuvres to move *Endeavour* away from the Hubble at a speed of 0.5m/s. Upon deployment, the solar arrays locked onto the Sun and the HST communicated directly through the Tracking and Data Relay Satellite System.

Clinton, Gore call

Later that day, President Bill Clinton and Vice President Al Gore made a 15-minute telephone call from the Oval Office to congratulate the crew on "one of the most spectacular space missions in our history".

The President also called the flight of STS 61 "an immense boost to the space program in general and to America's continuing venture in space".

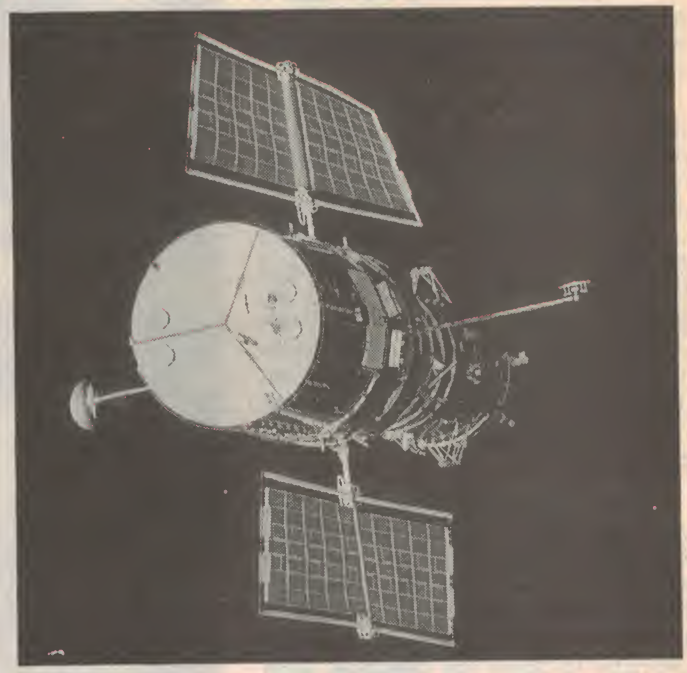
The crew went to sleep for the evening and were given the following day off. After sleeping in for an extra two hours, Dick Covey observed that the HST was "the brightest morning star" that he had ever seen. At the time, the HST was trailing behind *Endeavour* at 2.2km above and 167km behind it, at a separation speed of approximately 8.8km per orbit.

As during their rest day the crew had very little to do, Ken Bowersox filmed the Earth with a large-format IMAX camera, for an upcoming movie to be released in 1996. The crew also pressurised the orbiter's cabin back to 101.3kPa and Claude Nicollier tucked the RMS arm back into its cradle. Mission Control as a special treat faxed up comics from the Sunday papers, but the crew preferred to participate in their favourite space activity: watching and photographing the Earth.

Following a congratulatory call for Swiss-born Claude Nicollier from Swiss Minister of Internal Affairs Ms Ruth Dreifuss, the crew held an in-flight press conference with European and American journalists. During the conference, the crew said that their intense training had paid off and they were proud of what they had achieved in demonstrating sophisticated in-orbit servicing activities.

Later on, Jeff Hoffman celebrated Hanukkah festivities with his crewmates

Hubble repair: Mission Accomplished!



The Hubble Space Telescope begins its separation from the Space Shuttle Endeavour after a week and a half berthed in the vehicle's cargo bay.

by spinning a small top, a traditional holiday toy called a 'dreidel' in zero gravity. Meanwhile Claude Nicollier demolished a Hubble Space Telescope made from traditional Swiss chocolate.

The next day was spent in preparation for the return to Earth. Dick Covey and Ken Bowersox conducted pre-landing checkouts of *Endeavour* and its systems, as well as activating three hydraulic power units to test flight control systems for re-entry.

Covey and Bowersox also practiced simulated landings using a laptop computer and software named the Pilot Inflight Landing Operation Trainer (PILOT). The PILOT system hardware is a portable work station, with a high-resolution colour display and a hand controller with orbiter look and feel. The software used in the system was transferred from the Shuttle Engineering Simulator Software which was used to validate space shuttle flight hardware. This provided PILOT with orbiter handling and guidance characteristics. It is expected that the PILOT system will be used on long-term space shuttle flights to combat the deterioration of motor skills used in the landing.

Weather at the Kennedy Space Centre caused the landing of *Endeavour* to be brought forward by 90 minutes.

Following the de-orbit burn, *Endeavour* glided across Mexico and the Gulf of Mexico before crossing the west coast of Florida, north of Tampa before making a left-hand turn over Orlando for the final approach to the four-kilometre-long Shuttle Landing Facility at KSC. Here, after a flight of eleven days, *Endeavour* landed at 12:35am on 13 December 1993.

It is expected that the next Hubble Servicing Mission will take place in 1997, when several of the first generation scientific instruments will be replaced.

Almost immediately after the STS 61 flight was completed, the Servicing Mission Observatory Verification Phase of the Hubble Space Telescope began. This testing takes up to three months, and it was expected that the first corrected astronomical images would be released publicly in late January or early February.

Some key activities of the verification program include activation and engineering checkout of the scientific instruments, optical alignment of the COSTAR and Wide Field/Planetary Camera 2, decontamination of WF/PC2 detectors of foreign substances (by heating the detectors to drive off contaminants) and checkout of the first generation instruments.

The flight of STS 61 was again a perfect demonstration of the value of having humans in space, as they were able to use their talents to restore the Hubble Space Telescope back to its original state and allow it to do the science which was put on hold after its launch in 1990.

The 'ultimate time machine' is now back in business, with the best yet to come!

In closing, the author wishes to acknowledge gratefully the assistance of Debbie Dodds of the Johnson Space Centre, James Elliott of the Goddard Space Flight Centre, Kay Grinter and Margaret Persinger of the Kennedy Space Centre in the completion of this article. All photographs in the article are by courtesy of NASA. ❖

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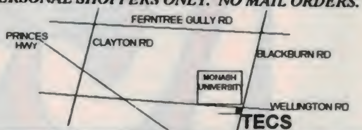

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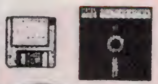

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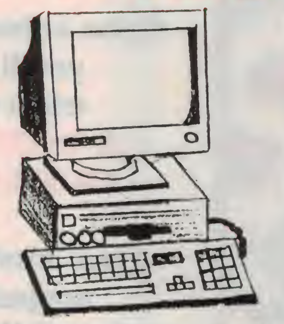

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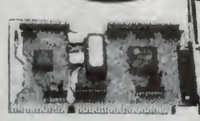

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SHORTWAVE LISTENING

with Arthur Cushen, MBE

New international voice for Papua New Guinea

Shortwave listeners were surprised recently to hear a powerful 100kW transmitter from Port Moresby carrying the Karai National Programme on a test basis. These broadcasts were unannounced.

The Papua New Guinea government had apparently installed the equipment as a matter of urgency, because of the failure of the present low powered transmitters at Port Moresby. (The old outlet of 9520kHz had been closed, while 4890kHz — though still operating — is to be used as a standby only.) The new transmitter is a Continental unit, using an incidence array as the aerial system. This gives good primary coverage throughtout Papua New Guinea, and extends from Cairns in Northern Queensland up to the Central Pacific. It also covers Fiji and the islands in that part of the Pacific area.

Officially opened by the Governer General, the early test transmissions were carried out on 9565kHz, and later the frequency changed to 9675. In a discussion with the Chief Engineer, he informed me that the aim is to find a channel on which the broadcast can run continuously for 18 hours a day, without a frequency change. The present schedule is 2000-1400. During the early test transmissions, the best reception was between 0800 - 0900. That hour long programme was mainly in English, with news in Pidgin at 0809; at 0815 Monday to Friday a feature programme; a programme summary at 0845; weather at 0858; and at 0900 another news bulletin in English. The frequency is relatively clear, and it is expected that 9675kHz will give a more satisfactory coverage of the target area.

The Chief Engineer is keen to receive reception reports on the coverage of this new high powered transmitter, and reports should be sent to PO Box 1359, Boroka NCD, Papua New Guinea.

It is interesting to look at the Pacific Islands and note that this is the first attempt at high powered shortwave broadcasting. At the present time, the Solomons, Vanuatu and Kiribat have low powered transmissions which are a relay of their domestic service; while Tonga and the Cook Islands (which operated on shortwave), are both temporarily off the air.

There is an interesting history of broadcasting in Papua New Guinea, commencing with a private operation before the war. During the war, both the United States Armed Forces and Australian Army Amenity Service stations were in operation. The latter had stations such as 9WK Wewak, 9LA Lae and 9PA Port Moresby.

After the war, with the assistance of the Australian Broadcasting Commission, shortwave services were begun. These used the call signs VLT and VLK and were reported on numerous frequencies. From the western half of New Guinea, administered by the Dutch, such stations as Radio Omroep Nieuw Guinea Te Hollandia were heard in 1951. Later, before the Indonesian take over (to become what is now Irian Jaya), the United Nations operated a station from Hollandia with the title, 'United Nations Temporary Executive Authority Broadcasting Services'. Gradually the broadcasting scene in the new Papua New Guinea settled, and stations in the provinces began to appear, such as VL9BR Rabaul, WL9CD Wewak, VL8BK Kerema and VL8BD Daru.

In recent years the call signs have been dropped, and regional stations are now known by a slogan such as 'Radio Northern District'. Currently there are 19 such stations operating in the low frequency bands, with the majority of broadcasters in the 90 metre band on 3200 - 3400kHz. Around 0900 and later those can be heard, each with their individual programmes.

Inland services close

For many years, the ABC has provided a service for listeners in the inland from shortwave transmitters, with programmes originating from Brisbane and Perth. The closure of the Queensland and Western Australian shortwave coverage means that now only three services for listeners within Australia are operating. These are from the three transmitters in the Northern Territory.

The arrival of FM coverage throughout the two States, satellite reception and improved availability of signals in the isolated areas has resulted in the closure of these two ABC sites. Both transmitting sites were closed in December, and so the ABC Domestic Services from Brisbane and Perth are no longer available. ❖

AROUND THE WORLD

ARMENIA: Yerevan broadcasts in English 0345 - 0400 on 7105, 10,344, 17,605 and 17,650kHz; 1945 - 2000 on 6065kHz — one of many frequencies. There are five English transmissions each day, and the best reception is at 0345 on 17,650kHz.

BELIZE: The Voice of America has announced that it is interested in offers to purchase its two 100kW transmitters. The closure has been caused by budget cuts. The 100 hectare site, which houses the two 100kW medium wave transmitters, is located at Orange Point. The VOA says that if it cannot sell the site, it may lease the air time — assuming that the Government of Belize would agree to this move. The operating frequencies are 1530 and 1580kHz.

HAWAII: KWHR is using 100kW and two aerial systems. The schedule is 000 - 0200, 17,555kHz; 0200 - 0600, 17,510kHz; 0600 - 1600, 9930kHz; 1600 - 1800, 7425kHz; 1800 - 2000, 13,625kHz; 2000 - 2200, 13,720kHz; and 2200 - 2400, 17,510kHz.

Programmes are beamed to China, Japan and the South Pacific. Reports should be sent to World Harvest Radio, PO Box 12, South Bend, Indiana 46624, USA.

ITALY: Adventist World Radio, Forli broadcasts in English 0700 - 0800 on 7230kHz, and Ekaterinburg in Russia has English from 1000 - 1100 on 7230kHz, and 2000 - 2100 on 7140kHz.

LEBANON: Broadcasting from near the Israel border, the Wings of Hope has made a frequency change to 9960kHz. It has been heard with identification at 2000, with signals to past 2100. This is one of only two stations on shortwave broadcasting from Lebanon.

OMAN: Broadcasts from the Sultanate of Oman, with its studios at Muscat, have been heard on 9735kHz with clock chimes at 2100, and sign-off at 2130 with part vocal National Anthem.

PHILIPPINES: The Far East Broadcasting Company, Manila is heard on 9410kHz, opening at 1115 with an announcement in English, and then a programme in Vietnamese. In this area, there is severe interference from the BBC World Service which is also on 9410kHz. FEBC is carrying the same programme on the alternative frequency of 15,095kHz.

SLOVAKIA: Adventist World Radio has leased time on two 250kW transmitters in Slovakia, and is broadcasting in English: 0100 - 0300 on 7270kHz, and 0300 - 0500, 9465kHz on one transmitter; while the other is used 0400 - 0500 on 9455kHz. Other broadcasts in English are scheduled for this AWR broadcast, but these are still tentative and on a trial basis.

USA: The Christian Science Church has sold WCSN Scotts Corner, Maine to Adventists World Radio for US$5 million. The money will be spent on installing a second 500kW transmitter at its site of WSHB Cypress Creek, South Carolina. The sales has been completed, and the old WCSN transmitter is expected to carry AWR programming shortly. The Voice of America in its latest schedule shows that it is using 30 relay sites in all continents except South America. The latest transmitter site to become operational is at Udorn, Thailand. The schedule includes 6045kHz, 2100 - 2300; 6070kHz, 2200 - 2300; 9560kHz, 1130 - 1330; 9680kHz, 1500 - 1700; 9715kHz, 1400 - 1500; 11,705kHz, 1330 - 1600; 11,785kHz, 1100 - 1400; 11,855kHz, 1700 - 1800; and 11,905kHz, from 1600 - 1700. Reports are welcomed by the Voice of America, Washington DC 20547, USA. ❖

This item is contributed by Arthur Cushen, 212 Earn Street, Invercargill New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time and 12 hours behind NZ Standard Time.

FORUM

Conducted by Jim Rowe

Assorted comments on servicing costs, listening tests and soldering safety...

I have another one of those 'loose ends' Forum columns for you this month, with a collection of comments on a variety of subjects — most of which we've touched on in recent months. There's two in response to items we published in the November column — one on servicing costs and the other on that test done in Germany which seemed to show that even audiophiles couldn't reliably pick the difference between vinyl and CD recordings. Another letter draws attention to an aspect of soldering safety that has been discussed but rarely taken seriously, until quite recently.

You might recall that in the November column, I reproduced part of a letter from Mr E.J. Lom, of Northmead in NSW. Mr Lom's TV set had developed a fault in an EEPROM used to store channel tuning and setup information, and he had encountered quite a lot of trouble trying to obtain a replacement EEPROM at anything like what seemed reasonable in terms of price.

Eventually he was forced to complain to the manufacturer's service manager, before receiving satisfaction — although then, he was sent the chip gratis. Which placed him in a dilemma, of course: he didn't know whether to complain about all of the hassles in trying to buy one at a reasonable price, or sing the company's praises for supplying one free...

Well, Mr Lom's letter has produced a response from reader Craig Beltran, of Berkeley Vale in NSW. And although he doesn't say as much, I suspect Mr Beltran may work in the servicing industry himself, because his comments seem to reflect this:

With regard to the item in the November Forum by Mr E.J. Lom, I believe this did not give both sides of the story.

If the technician at the service centre had 10 Mr Loms a day, then he would have to charge $100 an hour to make up the time lost in making decisions for people trying to fix their own equipment — making it more expensive for the ordinary person bringing in their equipment for repair. Many manufacturers will give technical advice to people in the trade and members of TESA or TETIA.

I agree that components from some manufacturers are over priced. But please, let's try and keep prices down, by letting the service centres and spare parts departments be more efficient. This will not be achieved by allowing the general public to bring in their old ICs and transistors for testing and diagnostic evaluation.

Thanks for those comments, Craig. Whether or not you work in the servicing industry, you've certainly drawn attention to that side of the story. And I take your point that time spent by servicing people on giving advice to customers still has to be paid for — even though people getting advice rarely want to pay for it. So everyone ends up paying a bit more, as you say.

It's also true, of course, that if manufacturers have to keep stocks of spare parts for significant periods of time, in order to cope with the needs of both service people and customers, this will inevitably make it necessary to charge more for them than their initial cost. Fair enough, I guess.

Consumer rights...

But as you say, we do have to consider *both* sides of the story. And while I agree that we need to consider the rights of manufacturers to get a fair return on their investment, and servicing people to get paid fairly for their time and effort, at the same time it's all too easy to forget the rights of the consumer. After all, the consumer has also made an investment, in the equipment they've purchased, and surely has a right to be able to keep it working, with a minimum of further outlay in terms of both time and money...

At times, I do get the strong impression that many people working in both the manufacturing and servicing sectors of the industry believe the consumer is merely some kind of 'necessary evil'. Our money is appreciated, but otherwise we're little more than a nuisance, to be fobbed off and disregarded whenever possible. And as for consumers like *EA* readers, with technical knowledge, who want to have a go at servicing their own equipment — how dare they! Supposedly we're not only wasting the industry's time, but also taking the food out of the mouths of its servicing people and their families.

I guess this is another of those situations where there's an inevitable conflict, in terms of rights. As I see it, the consumer has every right to expect replacement parts to be available, at a fair price, and also to choose if they wish to try repairing it themselves or engage a qualified service person to do it for them. And if they choose to fix it themselves, they have every right to expect full and easy access to whatever information or parts they need, again at a fair price.

On the other hand, manufacturers obviously have a right to charge what they need, in order to supply equipment, spare parts, information and so on — and still achieve a fair return on their investments. And servicing people need to be paid fairly for their time and effort, even when they're giving advice.

The trick, of course, is to reconcile these somewhat conflicting rights. In practice this is probably only achieved by pressure from 'trade practices' watchdogs and consumer groups, to bring in suitable legislation and enforce compliance with it.

By the way, I wouldn't be surprised if manufacturers who refuse to provide servicing information to consumers (and in some cases even servicing people whom they have not appointed as 'dealers') are already breaking existing laws. Perhaps its about time consumer protection groups tested this...

OK then, so that's another aspect of the servicing and spare parts question covered. Now let's look at the response to another item in the November Forum — the precis I gave of the article which appeared recently in *New Scientist*, about a study made by two German 'music psychologists'. The researchers had conducted listening tests involving some 160 people, many of them audiophiles, and had obtained result which suggested that very few could reliably tell the difference between CD and vinyl records, playing nominally the same recording.

New light on claims

I thought it was an interesting report, and one that seemed to cast new light on the claims made by many of the 'golden eared' brigade that they can hear all kinds of subtle differences in audio systems — and in some cases supposedly pick even the brand and grade of interconnecting cable. That's why I tried to present a summary of the findings...

Well, here again a reader has responded somewhat critically. The reader concerned is Mr Kerry Williams, of Eaglemont in Victoria, who seems to be a physicist at RMIT. His letter is quite interesting, raising a number of possible objections to both the research itself and (I think) my reporting of it. Here's what Mr Williams has to say:

Re the article reported in Forum November '93, describing experiments carried out by two German 'music psychologists', I feel an urgent need to cry caution lest this sort of reporting starts off yet another round of wild and unscientific speculation of the 'audible differences' kind.

You really are leading with your chin by publishing such material without due analysis. I have not read the New Scientist article, but will assume that your extract is accurate and contextual. If so, all that has been proved is that two identical performances sound identical to most listeners. This is hardly news!

Before attempting to draw any further 'conclusions', consider the following:

Identical recordings on CD and vinyl?! This surely is a contradiction and an impossibility; it must be true that there are differences between the CD and LP recording. After all one contains digital information, the other analogue. It is not unreasonable that some listeners could possibly discern a difference, unless it was submerged under another aberration such as speaker colouration, significant room resonance effects or the like.

If the program material was as 'identical' as possible, i.e., it was a recording made at the same time/venue using the same microphone feed and most likely master recorded on the same (digital) recorder, one would be likely to assume, in the absence of further technical facts, an identical digital source up to the point of reprocessing to the 44.1kHz digital CD standard on the one hand and D to A conversion for the vinyl cutting lathe on the other.

Almost any competently designed and assembled playback system should add (or subtract) minimally to the performance, so what 'differences' remain between the two program sources could be slight indeed!

The question remains: what specifically are the researchers, and your column, trying to demonstrate?

At a very superficial level, you appear to have shown that there is no reliably discernible difference between Vinyl and CD reproduction. If this is true, a large amount of scientific and engineering effort towards creating a perfect recording and playback system (namely CD) has been rather ineffective, wouldn't you say?

However, all may not be lost. Could it be that the experiment was not so scien-

tific after all? Maybe psychologists have a different understanding of science than physicists?

I would like to suggest a few generally agreed 'facts' which might form a basis for further meaningful discussion of 'audible differences' — not necessarily in order of importance.

Most press comment on the subject to date has been either grossly inaccurate, deficient in real content, or circular in form.

Analogue recordings of the 'golden age' (late 1950's to the early 70's) could be very good indeed. Just how good is only now becoming generally recognised, with reissues of classic material from early Decca, HMV and Mercury masters replayed on current 'state of the art' systems!

The domestic CD standard with its sampling rate of 44.1kHz is too low for accurate recording of music in the range 20Hz to 20kHz. Hence the gee-whiz magic fiddles (algorithms) being secretly designed into exotic (and not so exotic) players.

The rise time of music transients (especially percussion) can be much faster than comparable sinusoidal frequencies; 44.1kHz samples cannot 'see' these accurately. Whether this matters to the average listener is a legitimate area for research.

A sampling rate of five times highest recorded frequency would be a reasonable choice for the accurate recording of non-predictable signals. This choice would however be commercially problematic.

Filtering, especially at high slopes as used in CD systems, inherently produces sonic artefacts that may be audible to a critical listener.

High quality analogue vinyl-based systems can exhibit linear bandwidths to at least 35kHz and beyond.

Analogue disc cutters and playback cartridges produce large amounts of distortion, some of which is euphonic.

Some listeners are more aware of macro sonic events, whereas others are particularly sensitive to micro events (fine detail).

It can be shown to some extent that CD is good at defining macro data (clarity) and good quality vinyl excels at reproducing micro data (detail).

There are likely to be subtle audible effects that are not currently defined, recognised or measured. The 'cable debate' probably contains many of these, both real and imagined.

It would be refreshing to build arguments on facts such as these, and others that can no doubt be suggested by your readers, and leave the wild speculation and popular, but misguided, opinion to other Forums. Why demand a black and white answer anyway? Listeners will make up their own minds about which systems they prefer to hear, regardless of how many 'tests' can be made to prove a point one way or another.

Meanwhile, to one (hopefully) scientific journal quoting from another, let us please base future discussion firmly on scientific methods of evaluation — no matter how esoteric the nature of the 'research' carried out.

Hmmm... Thanks for those comments, Mr Williams, and I guess no-one can argue with many of the points you make. In fact I believe I've made quite a few of the same points myself, in previous columns and perhaps in different words.

What is 'due analysis'?

In fact because of this, I'm not really clear on why you accuse me of 'leading with my chin' in publishing the precis of the report concerned, without what you describe as 'due analysis'. Are you suggesting that we should never publish any items like this in *EA*, without discussing it at length?

This is hardly feasible — we're a commercial magazine, not a learned journal, and we have to keep readers interested enough to continue buying the magazine. If we never published anything without accompanying it with a lengthy 'analysis', I suspect we'd lose most of our readers quite rapidly — as well as having to sell the magazine for considerably more than its current price, to pay for all the experts we'd need. It would be the most effective way of committing commercial suicide, I suspect.

In any case, your suggestion that we were somehow amiss in publishing even a brief precis of the report, without a 'due analysis' or 'scientific evaluation', seems to imply that our readers are incapable of drawing their own conclusions. I certainly couldn't agree with this; my impression is that large numbers of *EA*'s readers are more than capable of sorting most things like this out for themselves — individually, as well as collectively. That's why we have a column like Forum, in fact, and the comments I reproduce in it from readers (including yourself) surely confirm this point.

I must say that your initial point about 'identical' recordings also seems rather like hair-splitting. In the precis I was using the term purely in a nominal way, to mean what you yourself went on to describe: CD and analog vinyl records of the same original master recording. That appears to be what the researchers used in the tests, anyway.

Your description of this as a 'contradiction and impossibility' seems all the more pedantic, when you say yourself a couple of paragraphs later that 'what differences remain between the two program sources could be very slight indeed'! That was precisely the point being made, surely — and yet it's this very kind of distinction that the golden-eared audiophiles claim to be able to make reliably...

Finally, you also seem to be suggesting that if few people can in fact tell the difference between CDs and vinyl LP recordings, then all of the R&D effort behind CDs has been 'ineffective' — because they're therefore not significantly closer to 'perfection' than LPs. But was the R&D ever *intended* to produce a 'perfect' recording medium, and in what sense?

Frankly, I'm inclined to think that most of the motivation behind the development of CDs (and other digital media, for that matter) has been economic, not technical. We technical people might like to believe that the digital revolution is all about technical challenges and a striving towards technical perfection, but I suspect in reality it has more to do with the mundane business of making greater profits.

This theory certainly explains the current drive to sell compressed digital audio media like DCC and MD, which even the manufacturers admit deliver lower-fi reproduction than CDs. It also helps explain why there's such a push to develop video CDs, whose quality of reproduction seems likely to be little better than VHS videotapes, at least for the immediate future.

Anyway, Mr Williams, thanks for your thought-provoking comments.

Soldering safety

And now for our last contribution this month, which was sent in by reader A.J. Lowe, of Bardon in Queensland. It's actually a little story Mr Lowe spotted in the November 1993 issue of *IEE News*, published by the Institution of Electronics Engineers in the UK. As you can see, it concerns a matter which has been raised once or twice before in these columns: the fumes generated during soldering with resin-cored solder, and the health risk they may represent.

The story concerned is titled 'IEE Warns of Solder Fume Danger', and it reads as follows:

THE IEE's Health & Safety Committee

has voiced its concern that many people in the UK electrical and electronics industries may not be aware of the health hazards of working with rosin-cored solder flux, in spite of the fact that employers have a duty to inform them of the risks and precautions to be taken.

Rosin-cored solder flux, or colophony, is derived from naturally occurring resins obtained from trees of the Pinus species. Rosin is a complex mixture of compounds, mainly abietic acid and its isomers, whose composition varies depending on its source. The IEE Committee is highlighting warnings that rosin-cored solder fumes can cause respiratory sensitisation, possibly leading to occupational asthma, a prescribed disease under the Social Security Act 1980. Not everyone becomes sensitised, and symptoms may be seen not only in solderers but also in others who work in the same area or nearby.

COSHH regulations require employers to identify the steps which need to be taken to achieve adequate control — substitution should be the first consideration, with the aim of preventing sensitisation occurring. As there is no means of determining who will become sensitised, control measures should be implemented everywhere there is likely to be potential exposure to fumes. The regulations also require that no work shall be carried out which is liable to expose anyone to a substance hazardous to health unless a suitable and sufficient assessment has been made by a competent person.

Rosin-cored-solder pyrolysis fumes have an occupational exposure standard long-term exposure limit (eight hour TWA reference period) of 0.1mg/m^3 and a short-term exposure limit (10 minute reference period) of 0.3mg/m^3, as formaldehyde*, although these limits and the measurement method are currently under review by the HSE.

Further practical guidance may be obtained from 'Guidelines on the use of colophony (rosin) solder fluxes in the electronics industry', published by the EEA, Russell Square House, 10-11 Russell Square, London WC1B 5AE; price £11.00.

*(*HSE Guidance Note EH 40/93: 'Occupational Exposure Limited 1993')*

Well, what do you think? Of course this concern is not new; I seem to recall a TAFE teacher taking us to task a couple of years ago when we published an article on basic soldering techniques, for not stressing the need for everyone to wear both goggles *and* a respirator whenever they're soldering...

I suppose it may well turn out that soldering fumes *do* present a health hazard, at least to some of us. All the same, if the fumes are *that* dangerous, I wonder why we don't seem to have heard more about the health problems they cause.

After all, people have been using resin-cored solder for about 50 years now, and in the early days especially many production line workers, technicians and even engineers spent hours every day slaving over a hot soldering iron and breathing in the fumes — with a respirator nowhere to be seen. I've done quite a lot of it myself, and for that matter I still do a reasonable amount — yet like most people, I've never worn a respirator.

Nose-seeking fumes?

By the way, have you ever wondered why the resin fumes always seem to be attracted to your nose — no matter where you sit, or try holding your breath, or moving your head to the side? It's a bit like the smoke from a barbeque, which always seems to blow in your face regardless of which side you stand. Yet another corollary of Murphy's Law, I guess...

I suppose I'm also a little surprised that the danger seems to be from the fumes given off by relatively 'modern' resin-cored solder. When I started my training after leaving school, we had to use a smear of gooey brick-coloured soldering paste on our joints. This came in tins which were prominently labelled 'guaranteed non corrosive', but the fumes it gave off were much worse than resin-cored solder. If you accidentally sucked in a whiff of paste fumes, you *really* knew about it!

But please don't infer from these comments that I don't take this matter seriously; I do. There have of course been other cases where substances have ultimately been shown to be a health risk, despite having been used for many years without apparent problems. Perhaps many of us will indeed turn out to have some kind of subtle but nasty health problem, caused by all the soldering fumes we've inhaled over the years.

So if any other readers have more information on this, by all means let me know and I'll pass it on. If we *are* at serious risk when we're soldering, we'd better know. All the same, I don't relish the idea of having to wear a respirator whenever I do any soldering. I already have to wear a close-up magnifier, to see what I'm doing!

My thanks to A.J. Lowe for sending in the IEE story, and raising the topic for discussion. See you next month. ❖

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

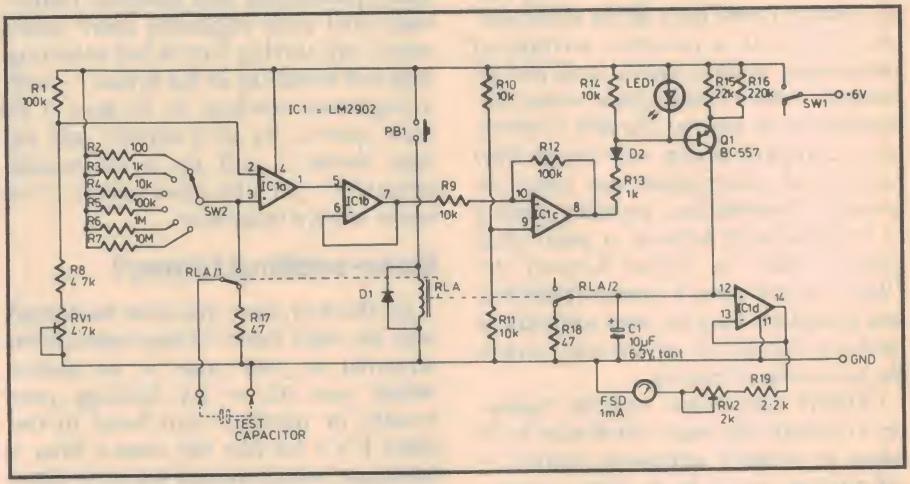
Large capacitor tester

Before pushbutton PB1 is pressed, the capacitor being tested is discharged through resistor R17, and the reference capacitor C1 is also discharged through R18, both through the normally closed contacts of relay RLA.

When PB1 is pressed, the relay is energised, and the capacitor under test is charged through the resistor selected by SW2 (R2 to R7). C1 is also charged at a constant current from the collector of transistor Q1.

As soon as the voltage of the test capacitor exceeds that at the inverting input (pin 2) of IC1a (part of the quad op-amp LM2902), its output at pin 1 goes high, as does the output of the non-inverting buffer IC1b. Similarly the output of the Schmitt trigger IC1c also goes high, which turns off transistor Q1, and so prevents capacitor C1 being further charged.

Now C1 will be at a charge proportional to the time taken for the test capacitor to charge to the determined level. This value is fed into the high impedance input of buffer IC1d, so the charge will remain constant for quite some time, during which the output from pin 14 can be read on the ammeter. On the lowest 1uF scale (resistor R7 selected), this reading in milliamps will be directly proportional to the capacitance being measured, with a 0.1mA current corresponding to a 0.1uF capacitance.



Stepping through each resistor from R7 to R2 gives successive 10 times increases. Hence the six capacitance scales in turn are 1, 10 and 100uF, and 1, 10 and 100mF.

To set up the meter, adjust trimpot RV2 to give a full scale deflection when measuring the maximum capacitance on any given scale. For example, with a known correct value capacitor of 10uF, do the adjustment with resistor R6 selected (the 10uF scale). If the meter reads too high or low, and RV2 cannot be further adjusted, then change the value of resistor R19 accordingly.

The next step — staying on the same scale — is to connect an intermediate value, e.g. 4.7uF. Adjust trimpot RV1 slightly (the combined resistance of RV1 plus R8 should be about 6.8k) after each pressing of pushbutton PB1, until the meter reads 470uA.

When this is achieved, go back to RV2 and again adjust for full scale deflection (FSD). Repeat minor adjustments of RV1 and RV2 until a good balance is achieved. Once this is done, the other SW2 positions should also read accurately, unless resistor tolerances are poor.

Note that the reference capacitor C1 should be a high tolerance, reliable one, like a tantalum.

D.T. Francis,
Cannonvale, Qld **$50**

80m shielded loop

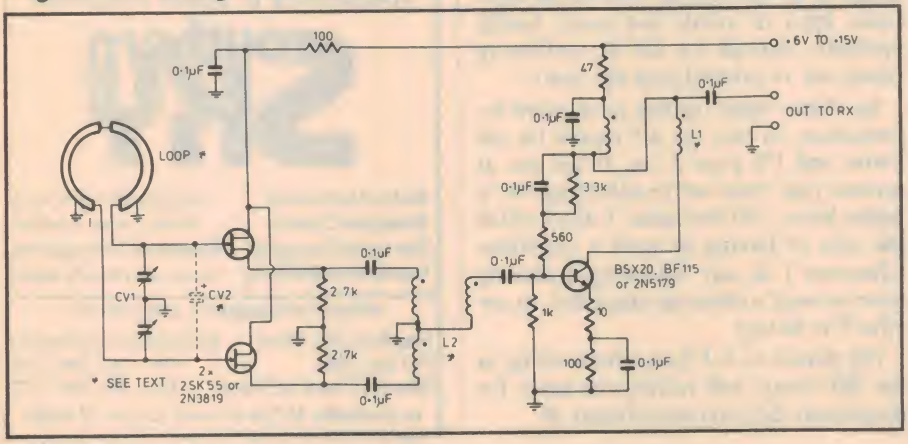
This shielded coaxial loop is very effective at minimising TV and other electrical interference on the 80m amateur band, and is quite sensitive. Note that it is directional, so should be mounted so that it can be turned as required.

The loop consists of a 3m length of 75 ohm coax, which is taped together in a circle of two or three turns. The screen should be removed as shown in the diagram over a length of about 25mm.

Variable capacitor CV1 is a two-gang broadcast type, but can be replaced with a single gang CV2 as shown, if full coverage is not possible. In this case, note that the frame of the capacitor will be 'hot'.

The coils labelled L1 and L2 are all 15 turns of 28SWG wire, wound on F37-61 ferrite cores or T50-2 rings. The two L1 coils are bifilar wound, while the three L2 ones are trifilar.

Stewart Farrant,
Yangebup, WA **$50**



Intelligent battery charger

I built this intelligent battery charger to give me the following features: fast charging at 800mA or 1.6A, using Delta-Peak (the peak in the charging rate) to terminate the process; C/10 slow charging, timed for four or 16 hours; C/100 trickle charging; manual switch selection for groups of NiCads less than, and greater than 7.2V; a LED to indicate the actual charging current flowing to the battery; and the provision for over-temperature cutout.

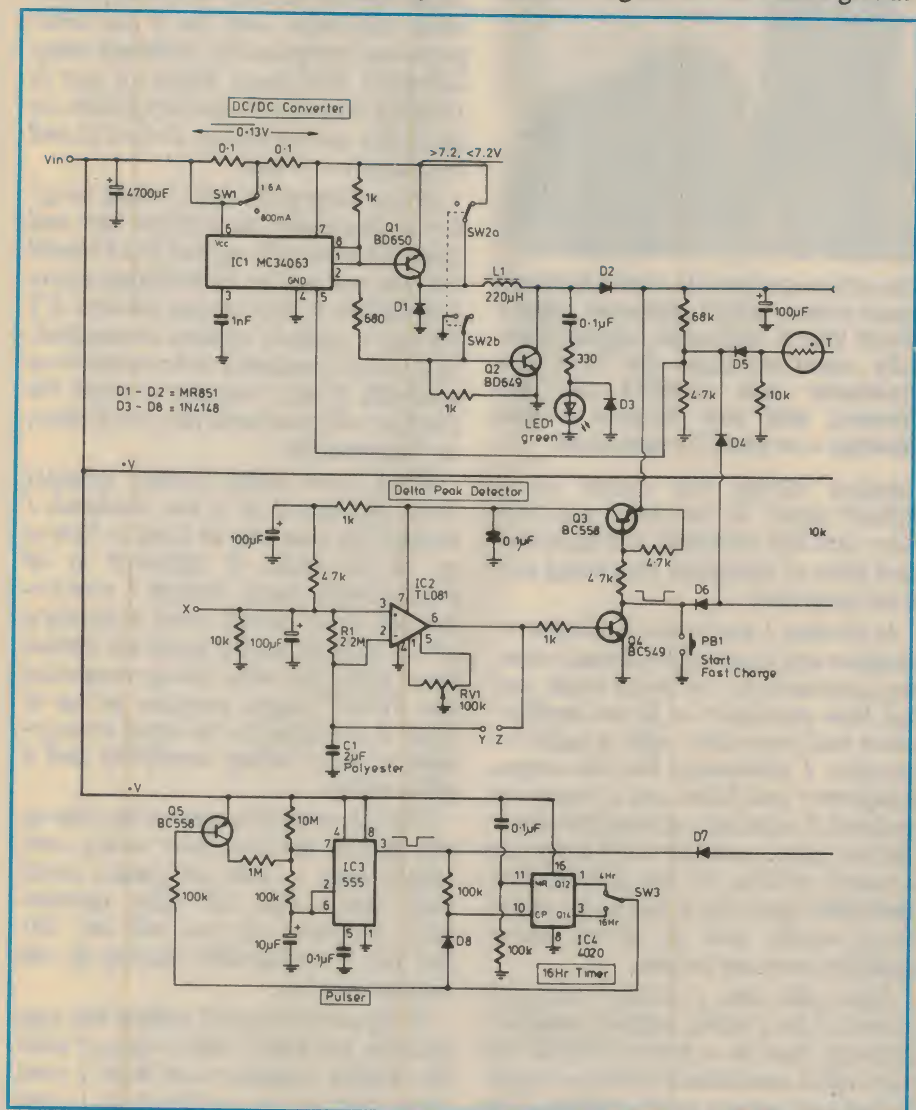
Slow pulse charging is used to give longer battery life, and easier current sensing design. After terminating fast charging, 4 hours is needed to ensure that all cells in a pack are fully charged; whereas 16 hours is used for standard charging only, without the risk of over-charging if you forget to turn off the charger.

Trickle charging (C/100) ensures that the battery remains near full capacity if unused for many weeks — if not trickle-charged, a NiCad will be down to 70% of capacity after one month, and even worse as it gets older. Non-pulsed C/100 charging can cause damaging large crystal growth, so C-rate pulse charging is used.

The over-temperature cutout is easily added for either the heatsink or the batteries being charged. Thermistor TH1 (RS307929, or Farnell 151597) is actually a thermal switch, which is pre-calibrated to change resistance quickly from 100k to 100 ohms around 57°C, so no calibration is required.

IC1 (MC34063) is a DC/DC converter with its own current-limiting (the peak current is sensed at pin 7), an internal oscillator with a frequency of operation up to 100kHz (determined by the capacitor attached to pin 3), and access to the inverting input of an internal comparator at pin 5.

The output is shut down if the voltage at pin 5 rises above an internal 1.25V reference regulator. Pins 1 and 2 give access to the collector and emitter, respectively, of the output switch transistor.



The circuit around IC2 (TL081) controls the fast charging. Calibration of this Delta-Peak circuit is critical to prevent over-charging and destructive over-heating of the batteries. The conservative approach terminates fast-charging as soon as the battery voltage stops rising.

To calibrate conservatively, in order to keep the voltage steady do not connect the output to a battery. Instead, hold down the START FAST CHARGE button (PB1) to keep the detector circuit on, and adjust trimpot RV1 to set the output at 6V.

The other method of calibration — used by professional chargers — does not cut out until the battery voltage is dropping at 1mV per second.

This ensures that maximum charge is applied in fast-charging mode, but runs a greater risk of battery damage from calibration drift or aging battery packs with cells of varying capacity. To calibrate this way, link Y and Z, and (with PB1 depressed) adjust RV1 to give 50mV between Y and X (X being more negative).

It is essential that a polyester capacitor is used for C1, as the leakage current even from a tantalum can cause a 50mV drop across resistor R1 — giving unreliable cutout.

Be sure to test the Delta-Peak circuit by charging a battery while monitoring the voltage and temperature. Your hand will be accurate enough to detect temperature rise, provided the battery pack can be opened so that you can touch each cell. Ideally, fast-charging should stop before there is any significant external temperature rise.

The slow charging feature is controlled by IC3 (555) — set up as an astable multivibrator — which delivers an active negative pulse for either a tenth or hundredth of its cycle.

Depending on the setting of switch SW1 (1.6A or 800mA), this gives charging rates of either 160/16mA or 80/8mA. IC4 (4020) is a 14-stage binary counter, with switch SW3 connecting to either output Q12 or Q14 to give a 4 or 16 hour timer.

Before the selected pin goes high, the 555 is a 10:1 pulser (inactive:active) since transistor Q5 is on. This becomes 100:1 when IC4 switches Q5 off.

Switch SW2 (DPDT) determines whether transistor Q1 or Q2 switches the output, for charging cell combinations greater than, or less than 7.2V.

Mike Richter,
Hornsby, NSW

$60

THE SERVICEMAN

Stories which show the dangers of jumping to conclusions!

In servicing electronic gear, it's all too easy to 'lead yourself up the garden path' and waste considerable time and money, simply by jumping to conclusions about the cause of the fault symptoms. The main stories I have for you this month show how it was just as easy to fall into this trap back in the days of valve equipment, as well as with modern solid state stuff...

Most of the stories I relate in these pages are about adventures that took place yesterday, last week or at most last month. But this time we open with a couple of stories that are many years old. I've chosen to use them because, although they discuss a forgotten technology, there is a lesson to be gained from them.

The first story comes from our old friend L.K., of Daintree in Northern Queensland. He tells this one against himself, since he only cured the fault by good luck. In his tale he begins by warning us not to jump to conclusions:

A wise old engineer was once recorded as saying "When fault finding, never make an assumption — for it may well lead in the wrong direction, or even worse, promote a false sense of security".

Many years ago, in the valve era, the import of this statement was soundly demonstrated when several servicemen, myself included, made a particular assumption during the course of a difficult repair. In the end it was only sheer luck that prevented a virtually unused piece of equipment from being cast to the scrap heap.

One of our stories this month involves metal valves, which appeared around World War II. Although rugged, their fully metal envelope did have one drawback: you couldn't see the filament, and how brightly it was glowing — or even if it was at all!

At the time, I was involved with the installation and repair of piped-music-cum-paging-systems for the motel trade, and had been summoned to fix an amplifier which had gone silent. After a quick inspection, I determined that the output transformer had failed and it being the weekend, I reluctantly advised the owner that the system would be out of action for a couple of days. He was fully booked and rather upset, but it had been 'one of those weeks' and all of my spare amplifiers were out on loan.

About this time, I noticed what appeared to be a public address amplifier gathering dust on a bottom shelf in the motel office, and asked if perhaps it could be put into service in the interim. The reply I received was a terse "If you can fix that one, you can keep it!" which always seems to me to be a sort of double negative. That is, I'm stuck with it anyway — fixed or not.

It transpired that the amplifier had come with the business when the present owner had taken over, but it had never performed satisfactorily. Although many attempts had been made to get it repaired, they had all met with failure; so he finally cut his losses, shelved it and purchased a new one.

With a history like that, I made no effort to investigate the problem then and there. We eventually agreed that I should take the unit back to the workshop where I could look it over as time allowed. If I felt that it could be repaired economically, it would be returned to be available as a standby. If not, I was free to retain the thing for whatever parts may be of value, as compensation.

Much later, while looking straight down the barrel of a wet weekend, I decided the time was at hand to have a go at the beast. It appeared to be professionally made (though I now forget the actual brand), even to having a circuit diagram pasted inside the bottom cover plate. The valve line-up comprised two 6V6-GT output pentodes set up in Class B, preceded by the usual arrangement of three voltage amplifiers and a phase-splitter.

One less common aspect of the line-up was that all the low power valves were 'metal' types — with an opaque metal shell rather than the more common glass envelopes. As you will see, this fact has a considerable bearing on the subsequent story.

As the set fired up OK without any sign of stress, and since I had no idea of what the original complaint had been, I went about checking its performance. I soon

found that with any reasonable signal fed to either of the inputs, there was insufficient voltage gain to drive the output valves to even half power. Any attempt at increasing the drive always resulted in severe distortion of the waveform. Yet in all other respects, it appeared to operate satisfactorily.

I spent a considerable time examining the circuit (which unfortunately was devoid of all but the most basic voltages) and comparing it with observed performance, finally coming to the conclusion that the unit had all the symptoms of worn out valves. Yet, given its history and the number of service organisations to which it had been taken, I couldn't believe that someone had never tried a new set as a matter of course.

I think that my reason for trying new ones was simply that I couldn't think of any other path to tread. As I have mentioned, for reasons known only to the manufacturer, the amplifier had metal valves ahead of the final stage. From memory, it used 6SH7's as the voltage amplifiers and either a 6F5 or a triode-connected 6J7 as the phase splitter. In any case, I had no metal replacements in stock, but I did have some 6SH7-GT and 6J7-G glass types. These were direct plug-in equivalents.

The result was not unexpected — they had absolutely no effect on the performance.

I was then on friendly terms with the proprietor of a service business operating from the same general locality as the motel. There seemed to be a fair chance that he would have encountered the amplifier too, so I took the liberty of calling him at home.

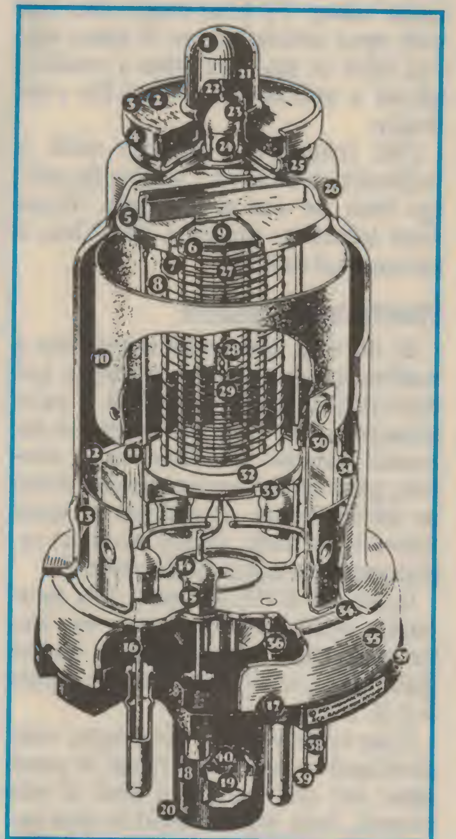
The mere mention of the motel and a description of the set brought a long adjective-riddled lament over the wires. "Take my advice", he continued, "and give it a miss. We spent hours on the thing, eventually deciding that it was unfathomable." He paused for thought, then... "I had an FJ Holden like that once — it just wouldn't go. Took it to everyone. Eventually I cured the problem by doing what the first owner should have done — I gave it a thorough selling!"

In full view!

All this left me sitting head in hands, gazing forlornly at the apparatus and wondering what more could be done. I was almost convinced that I would have to admit defeat, when I realised the answer was staring me in the face!

I was in this very position when light dawned — or rather light dimmed, because I noticed that the heaters of all but the output valves were hardly glowing. Excitedly I grabbed the circuit diagram to confirm that the power transformer provided two 6.3V windings; the final power stage being on a separate circuit to the rest of the set.

I jabbed the multimeter directly across the other secondary terminals and there it was, the solution to the enigma: less than four volts! Somehow this winding must have missed getting its full complement of turns and as Murphy promises, this was the one chosen to supply the metal tubes.



This diagram, reproduced from an early valve data book, shows the construction of one of the old metal valves. The various internal connections were brought out through insulating glass 'beads'.

At least, that's the only explanation I can offer, since the transformer hadn't any of the signs of stress that might be expected if shorted turns or poor connections were present.

I subsequently wired in a small filament transformer to replace the faulty winding, and away it went — with gain to spare, able to drive the 6V6's into overload. I proudly returned it to the owner with my account, which I suspect did not really cover my time and certainly didn't compensate all those others who had poured time and effort into the problem.

But I shouldn't claim too much credit for solving the riddle. It was only by chance that the original (metal) valve types were not in stock, which made the cause observable. Of course, there was also a bit of luck that made me sit and ponder in full view of the barely glowing valves!

Still, it does dramatically illustrate the importance of not jumping to assumptions.

Well now, all you transistor-ites: what do you make of that one? However, before I comment further on L.K.'s story, I'm going to tell you about an experience I once had myself.

Some time around 1970, a customer brought in a very early (1950's type) stereo amplifier. Which meant it had valves rather than transistors, to do all the work. Just like L.K.'s amplifier.

The complaint was that it had failed and been repaired by another serviceman, but the customer was dissatisfied with the results. It was distorting badly, and the serviceman was not prepared to do anything about it. (Yes, there were types like that in those days. As with death and taxes, they're always with us.)

It didn't take me very long to find the first of the two faults. The voltages on the anodes and screens of the output valves were way too high — 350V instead of around 200V. The reason turned out to be that the secondary voltage of the power transformer was 770V, centre tapped!

Now, that translates to 385 volts per side, which was a common value back in the days of the five-valve mantel radio with an electrodynamic speaker. After rectification in a directly heated double diode like the 80 or 5Y3, it delivered about 350 volts to the speaker field coil, which dropped about 100 - 150 volts before the remainder was passed on to the rest of the set.

Later, the figure of 385V was reduced to about 325V when permag speakers without field coils became common, and later still to about 280 volts when low impedance, indirectly heated rectifiers like the 6X4 were introduced. And finally, for the last of the valve sets the transformer secondary was usually 180 or so volts, rectified by a solid-state-diode bridge.

So it looked to me as though the previous repair might have been to replace a burned-out power transformer, and the other serviceman had grabbed the first one available, which just happened to be an old high voltage type.

The mistake was compounded by the fact that the amplifier did not use a valve rectifier anyway. Sure, its transformer had a centre tapped secondary, just like the old mantel radios. But instead of a vacuum tube rectifier, it had two of the

then-new OA210 solid state rectifiers. These had extremely low forward voltage drop; which exacerbated the high output from the transformer and was the first cause of the distortion of which the customer complained.

Since I was familiar with the old fashioned type of transformer which appeared to have been installed in the amplifier, I wondered what had happened to the 5V filament winding which was originally intended to power the heater of the (now absent) 80 or 5Y3 rectifier. Think about that for a moment — and by now you have probably guessed.

The five volt winding had been used to power the heaters of the output pentodes. They were supposed to run on 6.3V, of course, but the previous repairer had presumably decided that 5V was near enough. So the valve cathodes were being under-run, and were even less able to make use of the excessive HT supplied by the rectifiers.

I solved the problem by removing the OA210's altogether and fitting a 5Y3 into a spare space on the chassis. This still left excessive HT, since the amplifier had no speaker field coil to drop some of the surplus volts. As I recall, I got around this by fitting a 500 ohm/50 watt resistor in series with the supply.

This was a poor substitute for the missing (1500 ohm) field coil, but it did serve the purpose. The single 6.3V heater winding proved to have ample grunt to light up the amplifier's full complement of valves, so the customer went away happy, at last. (If nothing else, I'd proved to him that not all servicemen were villains.)

Now to get back to L.K. (No, I hadn't forgotten him!) As I read his story, I recalled the one told above, and I had a bet with myself that it was going to be the 5V rectifier heater winding which was causing the trouble. I would have staked my fortune on it. (Well — $10 at least!)

Of course, L.K. had warned us in his opening paragraph that we should not jump to conclusions. But I did exactly that, and I came a gutser, didn't I?

Still, I should have thought of those metal valves. I'd been caught like that with open circuit heaters in metal valves, back in the days when I couldn't afford a multimeter to test for continuity.

(We tested for voltage with a 'calibrated screwdriver', judging the voltage from the size of the spark. Valves were tested by plugging them into a known good socket!)

Wartime measure

By the way, those metal valves were a wartime measure. Metal envelopes had been tried in the very early days of valve technology, but were too expensive for general domestic use. However, in wartime, glass valves were too fragile for use on the battlefield, so millions of metal valves were made, mostly as direct replacements for common glass types.

In the late 1940's and early 50's, these surplus metal types found their way into the marketplace as replacements for the glass valves, often with results as related in L.K.'s story.

(Late in the war new valve types were developed to add to the range of metal tubes and still later, in a kind of role reversal, these were released in glass envelopes as the popular single-ended 'GT' series of valves.)

JUST FOR A LAUGH!

The family was watching a video when the fire started in the kitchen. The Fire Brigade tried hard, but the house was a write-off. Thick smoke had damaged everything that wasn't destroyed by the flames, and the distraught family wandered through the wreckage salvaging whatever they could. But there was little that could be saved.

The least damaged room was the lounge and there, in the corner, stood the TV and VCR. They were smoke blackened, but otherwise undamaged. A TV technician was called in to pass judgement on the condition of the equipment. On the bench, the tech removed the video cassette which had been playing when the fire started. Its title? *Smokey and the Bandit*!

Stephen Ward, Hobart, Tas.

So, not only has L.K. given us a moral lesson, he has also got me into reflective mode and had me deliver a load of old rubbish about a technology that has served us well, but is long past its 'Use-by date'. It's a bit like shoeing horses, isn't it?

Incidentally, L.K. has advised that he and Mrs L.K. are off on a well deserved six-month holiday, so we won't be getting any stories from him for a while. Or so he says — I'll bet something amusing turns up before he's back on the Daintree. Anyway, have a good time, L.K.

"Like an echo..."

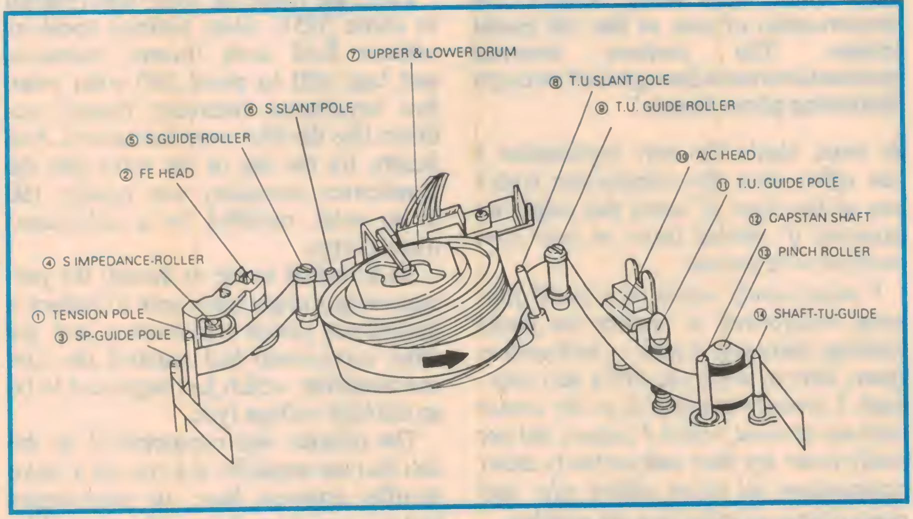
Now we return to the present, and shift our attention to a piece of modern technology.

Just the other day I had a most unusual fault in my workshop. It was a Sharp video cassette recorder and the customer claimed that the sound was making a 'funny noise'. When I pressed her for a more precise description, she could only add that it was "...like an echo".

They had left a tape in the machine, and when I set it to replay, the first thing I noticed was that the picture had a marked horizontal shake. The audio was only speech, so any fault in the sound was not particularly noticeable.

However, when I changed the tape for one of my own specialised test tapes, with an audio track comprising one of Bach's Brandenburg Concertos, the fault became excruciatingly obvious. The machine was suffering from a very bad case of audio 'flutter' — a rapid change in tape speed which causes the sound to warble.

Tape speed variations come in two basic types. One is slow change up and down, which causes the sound to 'wow'. This is usually a problem with motors or drive belts. The other fault is a fast varia-



In a typical VCR, the tape wraps around the rotating head drum as well as running past the fixed heads and guide rollers. Particles of contamination do not have to be very large to lift the tape away from the drum and disturb tape speed.

tion and in my experience, has always been caused by a bent capstan shaft.

It was a common fault in cheap cassette recorders owned by teenagers. They bent the shaft with rough handling and, such is the nature of teenage music, as often as not they didn't realise that anything was wrong. I have tried straightening bent spindles, but without any real success...

In the case of this VCR, I was certain that the cause was going to be the capstan shaft. Yet I couldn't find a thing wrong with it. I used a very sensitive dial gauge to check the spindle, and could read no eccentricity. So *that* wasn't the cause of the flutter. Next I turned the machine over and had a look at the capstan motor. It was one of those flat 'three phase DC' types, and I wasn't sure how I should go about testing it for rotational accuracy.

But I had the idea that if one of the six windings was faulty, it might (just might) cause the type of fault we could hear.

The best I could do was to use my oscilloscope to look at the inputs to each of the three phases. If one was irregular, it might point to the cause of the trouble. But all three inputs were rock steady!

I have had very wide experience with audio recorders, and have come to rely on my ears to verify tape speed and stability. In this case, I was so convinced that I had a capstan problem that I completely overlooked the real clue to the problem — which was a visual one, and was staring me in the face.

After I had spent nearly two hours poking and prodding around the capstan motor and its control circuitry, I realised that I wasn't going to get anywhere with electrical faults in the machine. I came to the conclusion that the capstan motor was U/S, and would have to be replaced.

However, before placing an order for an expensive replacement motor, I decided to see if I could borrow one from a colleague who specialises in Sharp service. And since I didn't have a complete service manual, with its list of part numbers, I tucked the whole machine under my arm and marched off into his workshop.

As it turned out, he wasn't particularly busy at the time, so he elected to put the machine on the bench and see if he could confirm my diagnosis of a faulty capstan motor. He agreed that the funny sound certainly pointed to the motor, and spent several minutes examining the shaft and bearings, just as I had done.

Then, he looked up at the monitor, put his finger on the screen and thought for a moment. Finally, he switched the machine off and began to examine the drum.

Taking a cotton swab dipped in alcohol, he scrubbed at the surface of the upper drum. I pointed out that I had already cleaned the heads and tape path, but he insisted that another cleanup wouldn't go amiss.

And he was right! Although it took several minutes to remove the fouling, it was fully effective and next time the machine was put into play both sound and picture were perfect.

Whatever it was that had been stuck on the drum, it was thick enough to lift the tape once each revolution. This accounted for the shake in the picture. And quite obviously, lifting the tape off the drum also caused a variation in the tape speed as it passed the audio head. It had nothing to do with the capstan!

Even after the cause had been found and removed, I still couldn't imagine how my colleague had determined that the fault was with the drum and not with the capstan. It turned out that it was the horizontal shake that pointed him in the right direction. I should have seen it myself...

The shake was really more of a 'flicker', and was perfectly stable at the field rate. In one field, vertical lines were quite straight — while in the next field, they took a pronounced hook to the left.

If you think about it, lifting the tape off the drum surface is the same as increasing the drum diameter. Then the tape speed has to increase momentarily, to accommodate the increased diameter.

I felt a bit foolish for not having seen the problem for what it really was. But then I consoled myself with the realisation that there are so many possible faults with a modern VCR that no one person can have seen all of them. It's likely that I've solved faults that completely foxed my friend — it's just that he didn't tell me about them!

Videotape lifetime

Now, another story — still on the subject of videos, but this time on the tape rather than the machine. It's not really a servicing story, yet it does have a bearing on the subject and will help fill an empty space at the end of this column.

A customer recently asked me how long a videotape recording should last. I'm afraid that I replied with the old wisecrack about the length of a piece of string. As I explained to him, the very best quality tape could be worn out in a week if it is played all day, every day. On the other hand, the cheapest junk tape might last forever if it is never used.

As it turned out, this was not the answer he wanted. He was concerned particularly about some camcorder material that he wanted to include in the family archives. He wanted to know if the pictures would deteriorate in storage. It so happens that the subject has been raised before in this magazine.

Back in August 1988, a correspondent wrote to *EA*'s Editor complaining that he could see significant degradation in his VHS recordings after just a few years. He commented that

Continued on page 81

When I Think Back...

by Neville Williams

Charles D. Maclurcan: Engineer, businessman, hotelier and top Australian amateur broadcaster — 2

While helping to set the scene for public broadcast stations, Charles Maclurcan also directed considerable effort to promoting normal two-way communication between amateur operators, locally, interstate and worldwide. And realising that they might soon be banished to the unused part of the spectrum below 200 metres, he set out to investigate and demonstrate its potential. This was before being overtaken by full-time family business committments.

Australia-wide, but especially in the Sydney area, Charles Maclurcan provided a commendable role model for post-war amateurs.

On the basis that there was strength in numbers, he did so from within the ranks of a restructured WIA (Wireless Institute of Australia), where he served as Vice-President to Ernest Fisk and later as President in his own right.

Typically, *Sea, Land and Air* magazine for February 1, 1922 (et seq.) recorded a well attended meeting of the WIA, NSW Division, where the results were announced of a successful six-week wireless receiving competition conducted on Sunday mornings from 2CM at Strathfield — Maclurcan's own station. It was said to have been the first such competition in Australia. Using both telegraphy and telephony, the transmitter power could be varied in steps by switching up to four V24 valves in parallel as the oscillator. Four other switchable V24's served as a Heising modulator. The power supply employed a 1/4hp AC to 600V DC motor/generator set, with a step-down transformer for the filaments.

At the April, 1922 WIA meeting, Charles Maclurcan reportedly presented a lecture describing the construction (or reconstruction) of an audio transformer — a not-unusual project in that era, because of recurrent burn-outs. Questioned about the effect of eddy currents in the core, he suggested, facetiously, that eddy currents might be more cooperative if identified by their full name: 'Edward Currents'. (Humour, 1922 vintage!)

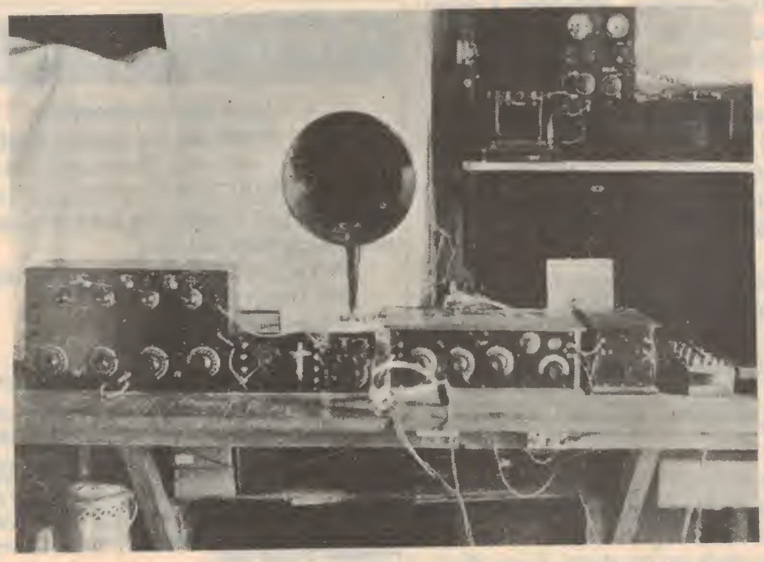


Fig.5: Long distance reception depends as much on the receiver as on the transmitter. Pictured is the long distance receiver in use at 2CM during 1923.

At the Annual Meeting on May 1, 1922, in the absence of the President E.T. Fisk, Charles Maclurcan took the chair and was subsequently re-elected as one of the Vice Presidents, with Phil Renshaw as Hon. Sec. and Malcolm Perry (AWA) as Hon. Treasurer.

Low power records

As distinct from *Sea, Land and Air*, copies of *Wireless Weekly* from the early 1920's are dotted with references to pace-setting long distance contacts or reception reports relating to 2CM, using low transmitter power — i.e., eight watts or less. Included were reports from Darwin, New Zealand, Pago Pago and ships at sea.

The wavelength/frequency used for the tests is not stated but, by inference, it would appear that, even at this early stage, Maclurcan was investigating the behaviour of wireless waves in the region 'below 200 metres' (i.e., frequencies above 1.5MHz), to which the amateur fraternity was to be confined once public broadcasting had been established.

The December 8, 1922 issue of *WW* reports that special low-power test transmissions from 2CM were heard in daylight by Mr L.V.G. Todd of Tamworth, 200 miles (310km) north of Sydney, and by Mr Channon of Inverell at 350 miles (490km).

Mr Channon's receiver was using a single Expanse-A valve and, according to his report, the CW signals were coming through with power to spare. He was surprised to learn that the plate

input power at the transmitter was a mere 0.4 watt!

To cap this, a further test a few days later with Mr Todd resulted in clear daylight reception with a transmitter input power of 1/7 watt!

A one-page follow up story in *Wireless Weekly* for October 12, 1923 was headed 'More World's Records Gone West'. It details preliminary day- time tests on Sept. 24 and 28, 1923 between 2CM and a Melbourne station, 3JU — operated by the renowned Ross Hull. ('The Ross Hull Story' appeared in the February 1989 issue of *EA*). Ross reported that he had been able to copy signals with 2CM's power reduced respectively to .07 and .044 watt — in the latter case despite a degree of jamming from the Melbourne PMG station VIM.

Build your own sealed set!

With public broadcasting due to begin shortly ... *Wireless Weekly* will continue to publish articles on non-regenerative receivers, both crystal and valve, which will be suitable for broadcast reception. Care must be taken to ensure that the sets will receive only on 350 metres, although a variation of 10% above and below that wavelength will be allowed. Each set must be enclosed in a box suitable for effective sealing. The Radio Inspector, McDougall House, Sydney, will seal the set on a fee of 2/6d being paid.

(From Wireless Weekly for October 26, 1923. 2SB Sydney, later re-registered as 2BL, came on air on November 23, as the first sealed-set station, with a designated annual subscription fee of 10 shillings.)

Trans-Tasman on 3.7mW

These contacts were followed by supervised tests between Charles Maclurcan 2CM and Frank Bell 4AA at Waihemo, Shag Valley, New Zealand, commencing at 9.00pm on Wednesday October 3, 1923.

Beginning at 'full power' of seven watts, the input was progressively reduced to 0.0037 watt (a rounded decimal) with Bell acknowledging reception with: 'OK QSA. Sigs strong and steady throughout. Another world's record gone west. Mim. Congratulations OM. G.M. Bell'.

The point should be made, perhaps, that credit for such reception belongs as much to G.M. Bell for his receiver, as to Charles Maclurcan for his transmitter. (The same remark would apply to Messrs Todd and Channon, above).

As if to emphasise that the contact was no fluke, Maclurcan received an unsolicited telegram from a listener in Charters Towers, Qld, which read: 'HEARD YOU ON LOWEST POWER LAST NIGHT. ODGERS.'

Apart from coverage in the technical press, *Wireless Weekly* (January 4, 1924) reports that the low power tests were written up in the *Sydney Morning Herald* under the heading 'Wonderful experiments by NSW amateurs'. The *SMH* detailed the trans-Tasman contact and said that in previous weeks, Charles Maclurcan had, himself, been experimenting with receivers, with particular emphasis on unpretentious circuits able to receive overseas code transmissions, while drawing minimal battery power.

Behind all this lay spirited argument in the early 1920's between three major groups:

- Professional operators, who saw wireless primarily as the communications medium of the future, with formally trained operators (like themselves) exchanging messages in Morse code. Morse, they maintained, would always be preferable to telephony under adverse conditions. Speech and music transmissions would be a waste of time and technology!
- Traditionalists, who accepted wireless as an all-purpose medium but considered long and medium waves to be the natural and useful part of the spectrum. The use of relay stations and/or increased transmitter power were seen as the obvious answer to long-distance reception, with Sydney's new 5000W station 2FC a prime example.
- Visionaries like Charles Maclurcan and Ross Hull, intrigued by the behaviour of short waves — below 200-odd metres. Range appeared to depend on wavelength and day/night propagation rather than power. As they saw it, high-power multi-hop relays would be inherently costly and inefficient.

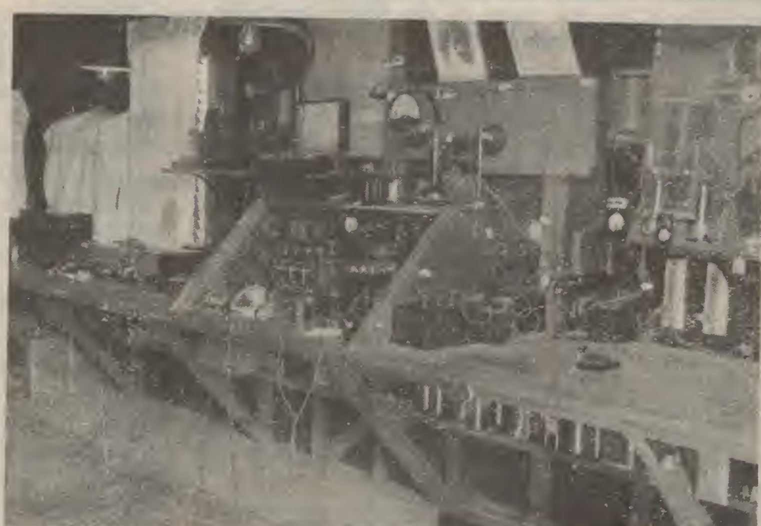


Fig.6: The wireless room at 2CM, Strathfield in 1923. Central is the transmitter normally used for the regular Sunday Night concerts. Set up on 388 metres, it provided an excellent signal, even though of modest power.

Bridging the Pacific

The *SMH* article went on to say that amateur operators Charles Maclurcan and Jack Davis were planning to travel to America aboard the *RMS Tahiti*, on which would be installed short-wave equipment similar to what had been used in the tests from Strathfield. A detailed log would be kept of the range achieved throughout the voyage, for contacts back to Australia and onwards to America.

Why Jack Davis? It would appear that he was a young and progressive engineer and a keen amateur, as well as being an employee of AWA, with its links to Marconi, UK. As such, he would be well qualified to observe the performance of the conventional Marconi marine equipment with which the *Tahiti* was fitted.

Equally, he could evaluate the comparative peformance of Maclurcan's high frequency technology, on which Marconi/AWA's proposed 'Beam Wireless' system was to be based. (See 'Australian Radio Communication Services' by L.A. Hooke, in the *Complete Proceedings of the World Radio Convention*, Sydney, April 1938). It would seem that some contemporary amateurs had had reservations about low-power shortwave transmission tests, even to questioning whether a valve would oscillate reliably if the input power was as low as had been reported.

Maclurcan's characteristic answer was to set up a practical demonstration at his Strathfield home, and invite members of the Kuringai Radio Club to be present and monitor all readings. I quote (*Wireless Weekly* 12/10/23):

The power input was regulated by the filament rheostat of the Kenotron rectifier valves. The measuring instruments used were a Weston volt ammeter, model 280, and a Paul unipivot galvanometer with thermocouple, both of which had been certified correct within 1% by Mr E. Joseph.

The President of the Kuringai Club, Mr E. Wilson, manipulated the oscillating wavemeter which was used to make sure that the transmitter was still functional. Other members of the Club recorded and checked the meter readings.

Beginning at 3.5V and 4.2mA (.0147W) the input was reduced progressively to 0.4V and 0.8mA (0.00032W) at which point *the valves were still oscillating strongly. All members present showed their good faith by signing Mr Maclurcan's log.*

As a valve man from way back, I must take off my provervial hat to anyone who manages to operate a self-excited oscillator with an HT supply voltage of 0.4V. On the other hand, I am conscious that, as described, the operating conditions are ambiguous, as it often was with directly heated valves. An HT of 0.4 volts in respect to what?

If referenced to the negative end of the filament, the plate would itself be negative with respect to most of the emissive surface — a most unpromising situation. On the other hand, if referenced to the positive end, the plate voltage would effectively be 2.4, 4.4, or 6.4V with respect to the negative end, depending on the filament supply. With AC on the filament, the situation would be different again.

Official recognition

This reservation aside, it is evident that Charles Maclurcan's approach to wireless/radio technology was both informed and methodical. In the early 1920's, when expertise in the subject was very thin on the ground, it is not surprising that the Authorities should acknowledge his standing in the industry.

So it was that the July 1922 issue of *The Australian Wireless Review* reported the second of the special roles accorded to Charles Maclurcan by the Federal Authorities. With NSW Radio Inspector Crawford unable to keep up with the growth of the amateur movement in his area, Charles Maclurcan was appointed an Honorary Inspector, along with H.E. Stowe, E.B. Crocker and J.W. Robinson. In particular, wavelength/frequency measurements made through 2CM would be accepted as accurate and official.

In the next issue (August 1922) an unnamed — but apparently impatient — staff writer stated that sufficient amateur broadcasters had appeared on the air to provide and operate a formal roster for two to three hours of voluntary broadcasting every night of the week in the Sydney area.

We don't need to wait for the Government to make up its mind, he suggested...

Fig.7: Charles Maclurcan (left) and Jack Davis and their bolt-on 'ham shack' on the stern of the RMS Tahiti. At sea, vibration proved to be a serious problem.

He went on to suggest that 2CM's existing Sunday evening broadcasts should be central to the proposed roster, kept clear of interference from other stations and regarded as an example of reliability, signal strength and presentation.

In drawing up the roster, precedence should be given to stations which could offer a powerful, well modulated signal. Other aspiring amateur broadcasters should seek the guidance of their more successful peers and pursue their experiments at least 40 metres away on the dial, to minimise the risk of interfering with any rostered broadcast.

Wireless every evening

Elsewhere in the same issue, the magazine listed a dozen amateur broadcasters or groups in the Sydney area which were, indeed, working out a provisional schedule, each contributing 30-minute sessions extending to about three hours each evening. They were identified as:

2GB	405m	Mr Marks, Rose Bay
2JM	365m	Mr Marsden, Edgecliffe
2CM	380m	Mr Maclurcan, Strathfield
2DS	375m	Mr Jack Davis, Vaucluse
2BB	350m	Mr Crockett, Marrickville
2LI	410m	Radio College
2LX	200m	Burwood Radio Club
2KC	415m	Mr Fry, Croydon
2WV	410m	Burgin Electric Co
2UW	350m	Mr Sandel, Manly
2WC	250m	Mr Morey
2ZG	380m	Mr McIntosh, Lane Cove

The magazine was seeking similar information about potential amateur broadcasters in Queensland, Western Australia and New Zealand. All told, according to the *Macquarie Book of Events*, there were some 200 amateur radio stations in Australia at the time.

While the amateurs certainly helped rally a basic but keen group of wireless listeners, their efforts were eclipsed when official broadcast stations began to appear on air from November 1923 onwards. By present-day standards, the new public broadcasters were quite primitive but, with commercial backing, professional — even if immature — staff and extended schedules, they soon dominated the scene.

With the emergence of public broadcasting, it was perhaps inevitable that the licensing authorities worldwide should jointly ban the transmission of music by amateur stations, confining their role to experimentation and communication within their own ranks, by means of speech, tone or code. It was this move which Maclurcan had foreseen.

Maclurcan and Davis

In its issue dated February 22, 1924, *Wireless Weekly* mentioned the 'farewell transmission' from 2CM on the previous Sunday evening — this was a few days before Maclurcan's departure on the projected voyage to America. The reporter had obviously been amused by his send-up of the market reports which 2BL and 2FC had apparently begun broadcasting, with much gravity. Said Maclurcan:

Sussex St remained stationary. I'm very

glad to hear it, because last time I was down that way it was moving round in circles. I'd been to a dinner — but I'll spare you the details.

Treacle was scarce, owing to adverse reports from the Great Cobar treacle mine. But a fresh vein is expected to show up shortly. Also the miners are complaining that they are insufficiently paid — but they're on a sweet thing, already!

Onions were greatly affected. This is an affecting fruit any- way. I've been so affected, at times, by an onion that I finally burst out sobbing!

With Jack Davis, Maclurcan sailed on the *Tahiti* on February 28, 1924, the latter leaving behind a technical article for *Wireless Weekly* published in the February 29 issue: 'How to Keep Below 10 Watts'. Based on a simple self-excited oscillator, the author explained how to optimise the aerial feed current as shown on a thermocoupled meter, while conserving plate current and staying within the 10-watt limit imposed by the licence.

On board the *Tahiti*, the amateur wireless gear was installed in what looked rather like a small garden shed bolted to the after deck, with an aerial and counterpoise strung to the mast. Officially, it would operate under the callsign 2DCM. What the operators didn't anticipate was that, at sea, the 'shack' and its contents would vibrate in resonance with the ship's propulsion system!

Showdown at sea

Testing began with the ship's departure from Sydney, but was interrupted shortly after by a burned-out generator and a number of failed valves, presumably due in part to rough seas and severe vibration. Replacements were obtained in New Zealand but, in the meantime, contacts of up to 2000 miles had been made using a standby 1.5W transmitter.

An Australian amateur and WIA Vice President, F. Basil Cooke, undertook to coordinate the on-shore monitoring. But he faced frustrations of his own with fellow amateurs, who interfered with the contacts — unconcerned by, or unaware of, the *Tahiti* research project.

An interesting sidelight was that another Australian wireless amateur, 2JM, helped keep the schedules spot on time by transmitting time signals, obtained from a Mr James Nangle's private observatory — a stellar amateur!

In the interview with *People* magazine, quoted in Part 1, Charles Maclurcan confessed that they had not been particularly welcome aboard the *Tahiti*. 'Professionals and amateurs don't love each other much', he commented!

As it turned out, when the ship was 700 miles from Australia, the ship's radio lost contact with Sydney — but Maclurcan and Davis kept right on transmitting and receiving each night. They were still in contact when the ship reached San Francisco, which that city's newspapers described as little short of colossal.

On the return journey, the Mayor of San Francisco, who was on board, wanted to send a sheaf of telegrams back to his city. The ship's own radio was out of range, and the professional operator had to swallow his pride and seek Maclurcan's assistance.

Back in Sydney, Charles Maclurcan received a congratulatory letter from Ernest Fisk. It, together with his log and other related papers, are on file at the NSW State ('Mitchell') library. I understand that Basil Cooke's log is filed with them, replete with references in the vernacular to local amateurs who created unwarranted interference during the tests!

(One of Maclurcan's many receivers is stored for safe keeping at Sydney's Power House museum, along with a scrap book. They are not currently on display.)

As it turned out, the *Tahiti* experiment demonstrated to amateurs on both sides of the Pacific that two-way contacts on shortwave, using modest power, were entirely practical. They also shed further light on the shortwave 'skip' effect — a phenomenon which Maclurcan and other amateurs worldwide continued to observe. In the *People* profile he is quoted as saying:

"By appointing official checkers all over the world, we verified this peculiar fact."

Radio magazine (August 15, 1928) made the point that Maclurcan had also shown the way to working Britain and South Africa on 20 metres. It was now up to his fellow Australian amateurs, he had said, to make better use of the band instead of leaving it to 'sleep so peacefully'. Ironically, he was to vacate the scene himself within a couple of years. 6: The wireless room at 2CM, Strathfield in 1923. Central is the transmitter normally used for the regular Sunday Night concerts. Set up on 388 metres, it provided an excellent signal, even though of modest power.At the time, however, Maclurcan was able to express his opinions through more than his own amateur station and the technical press.

Curiously, for a fee of 100 guineas ($220) he prepared a set of 100 cigarette cards for W.H. and O. Wills, each featuring a technical snippet about wireless. As

Fig.8: A retired Charles Maclurcan looks back at one of the magnificent models he built in his younger days — a live steam loco. Amongst his other projects was an impressive radio controlled model of the battleship 'Lord Nelson'.

would have been the case in those days of undisputed puffing, they would have been perused, saved and swapped to obtain the full set.

In 1926, his personal news value in the community prompted a Sydney newspaper to commission him to prepare a full page of wireless news once a week. Many journalists were said to have envied his fee of sixpence a line... Apart from technicalities and station notes, the feature exposed him to countless ill-informed, prejudiced and even superstitious readers' letters, inviting characteristically whimsical responses.

Back to business

In the late 1920's, with his mother approaching retirement, Charles Maclurcan found himself progressively more involved in the operation of the Wentworth hotel, with less time to devote to amateur radio. The crunch came in 1930, when he had little choice but to divert his full time to business interests, in particular his family heritage, the Wentworth. He gave up 2CM and sold his equipment to a Newcastle buyer, who used it as the basis for a new commercial station. It would appear, however, that he retained a formal link with the industry by membership of the IRE Aust. (Institution of Radio Engineers, Australia).

While the Wentworth Hotel had been a popular — and profitable — rendezvous, it was not a good place to stay around 1930 because of blasting and other noise associated with construction of the Sydney Harbour Bridge and the road, rail and tramway access. The Hotel's one-pound ($2) shares had slumped in value to three shillings (30c), and it was facing ultimate bankruptcy.

Rising to the challenge, Charles Maclurcan addressed himself to a task which dominated the next 15 years of his life, working up to 18 hours a day and spending countless nights in a room at the hotel rather than going home.

In an operation which was arguably his greatest achievement (*People* magazine), Maclurcan turned his family's fortunes around to the point where, in 1937, he was able to envisage taking on a loan to cover the addition of 50 new bedrooms on two extra floors.

The bank agreed, on the condition that he undertake to continue as the Managing Director. The extensions were built and the shares climbed to five pounds ($10). But the effort had cost Charles Maclurcan his robust health and, by arrangement, Qantas Empire Airways acquired a controlling interest in the Hotel, to serve as their Sydney Headquarters and for the convenience of their stop-over passengers. But that's another story.

Fig.9: Retired, but not quite able to 'give the game away' — Maclurcan with an array of post WW2 equipment, surmounted by a photograph of his friend's ship on the Barrier Reef.

Charles Maclurcan, the businessman, had retired but the career of Charles Maclurcan, the amateur, was not quite finished. I was told by his sons that, around 1947, a friend had taken over a war surplus small ship to transport tourists to and around the Barrier Reef. At Maclurcan's insistence, he also purchased two Army 109 ex-disposals transceivers, which were modified for use on the amateur bands. One ended up on the ship, the other in the Maclurcan home.

Charles Maclurcan suffered a serious heart attack in 1951 but fellow amateurs, including the late Don B. Knock, sought to convince him that old amateurs are like old soldiers: they never die, even though they may have sold up their gear 20 years before!

People magazine carried a picture of an ageing Charles Maclurcan surrounded by an amateur 'rig' assembled from war-disposals modules. On the wall behind him is a great-circle map showing the compass bearings to major centres throughout the world. How much he used it is not stated, but the answer would appear to be 'not much'. Chatting with Pierce Healy, *EA*'s former amateur radio correspondent, I reckoned that, if anyone would have been aware of Charles Maclurcan on air, it would have been Pierce — particularly as they had both served as Presidents of the WIA.

Pierce said he had met Charles socially on two or three occasions and had been visiting Victoria during his own presidential year, when Charles Maclurcan's death was announced. But he could not remember contacting him or hearing him on air. Be that as it may, *People* magazine's last word on the subject was that he had ultimately found himself with 'a magnificent 80-20-10-6 metre transmitter in his home at Neutral Bay' (Sydney). But at the time of the interview, he was all set for a trip to Europe with his wife and radio was not a priority. As he told an old friend, he might be able to "build up to the pace again", but "for now, I'm really a retired gentleman".

"Correction. I'm putting on airs. I'm a retired bloke!"

Which brings me to the third distinction conferred on Charles Maclurcan by the Federal Administration. On his death in 1957, they set his callsign aside as unique to Australia's most notable wireless pioneer — never to be re-issued.

FOOTNOTE: With the material supplied by Mr Robert Maclurcan for use in this article came a tape, from the community FM radio station in Orange NSW. It carried a program of light classics, hosted by Bob Maclurcan, who had previously presented to the station a photo montage as a reminder of his pioneer father. The callsign: 2CME! But while Charles' son has done the occasional broadcast on FM, his grandson Richard is preoccupied with — computers!) ❖

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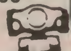

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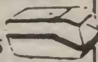

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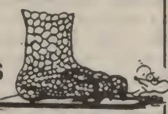

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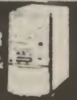

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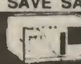

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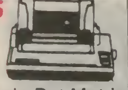

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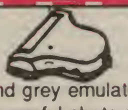

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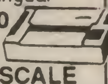

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Y16042..............................$29.95

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• Austel Approved.

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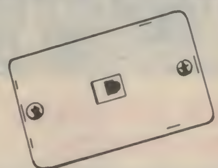

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• 6 position / 4 gold contacts.
• Screw terminating.
• 115mm x 70mm • Suplied with 15cm cord.

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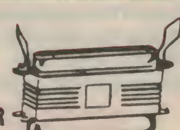
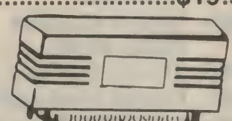


SCSI TERMINATOR

MAC SCSI inline terminator.
50 pin Centronics male to female

X15696..............................$19.95



NEW

SCSI TERMINATOR

MAC SCSI terminator - 50 pin Centronics male.
Single end passive type.

X15697..............................$13.95

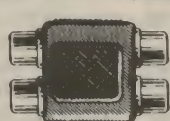
NEW

RCA PLUG TO RCA SOCKET

• Single RCA plug to 2 x RCA sockets

P10829..............................$5.50

NEW



RCA SOCKET TO RCA SOCKET

• Twin RCA sockets to twin RCA sockets for joining twin RCA plug to plug leads

P10827..............................$4.50

KEYBOARD ADAPTORS

NEW

6 PIN MINI DIN MALE TO DB9 FEMALE

X15685..............................$10.95

NEW

6 PIN MINI DIN FEMALE TO DB9 FEMALE

X15687..............................$10.95

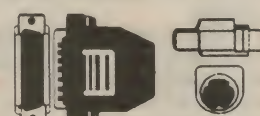
INTERFACE CORDS

NEW

MODEM CORD

DB9 female toDB25 male.
• Pin wired
• Length: 2.0 metres

P19015..............................$15.95

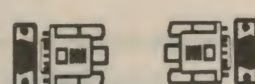


NEW

MAC CORD

MAC to Hayes Modem.
• MDP8 male to DB25 male
• Length: 2.0 metres

P19027..............................$15.95



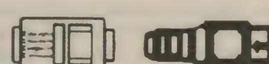
NEW

NULL MODEM CORD

DB9 female to female
• 6 pins wired
• Length: 2.0 metres

P19003..............................$15.95

NEW



KEYBOARD CORD

WYSE to 101 keyboard cord. 5 pin DIN socket to modular plug - 4 position / 4 contact.
• 4 pins wired.
• Length: 5cm.

P19037..............................$14.95

NEW KITS!

90-SECOND MESSAGE RECORDER

Remember the 16- second message recorder that came out in July last year?
Well now there's a 90-second version for all you "gasbags" out there! It features a larger power amplifier "pause " button, 90 seconds of continuous record time, zero-power memory storage and runs off a 6V battery.
Like its predecessor, this message recorder can be used in many applications such as a doorbell, answering machine or used to deliver instructions.
Silicon Chip. Feb. '94....................**$98.00**

200W INVERTER

Inverters are fast becoming part of peoples everyday lives. Whether it be business by running power appliances including power tools at building sites, or pleasure by using them when camping for lighting purposes or running TVs or refrigerators.
This compact 200W inverter can drive many power appliances and can work as part of a solar power installation. FEATURES:
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- Very low stand-by current
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- Peak-peak voltage equal to mains sine wave
- Under Voltage shutdown
- 30A Over-current limiting
- Fuse isolated output for safety
- 2KG mass

Silicon Chip FEB '94. ....**$199.00**

LED CHASER

If your new to electronics and your looking for an eye-catching project that is easy to build, then you cant go past this simple LED Chaser. It uses 10 light emitting diodes (LEDS) and flashes them around in a clockwise direction. It uses only 2 ICs and you'll learn about counters and oscillators while you build it.
It's ideal for shop front "attention grabbing" displays or even if you just want to learn more about digital electronics the fun way.
Silicon Chip FEB. '94.....**$21.95**

THE CHAMP "AUDIO AMP"

Been looking for a cheap and handy AMPlifier for all those audio projects?
Well here it is! The Champ. It's smaller than a 9V battery, only uses half a dozen components and will pump 0.5W into 8 ohms from a 9V supply.
It's just about the smallest amp you can build with standard sized components.
It uses the well-known LM386 audio amplifier IC.
It's small compact and most importantly cheap, and will fit into the tightest spaces.
Silicon Chip. FEB '94 ....**$9.95**

VOICE OPERATED AUDIO SWITCH

This simple circuit uses an input audio source to activate a CMOS switch without the usual harsh ' clicks". It uses only one CMOS IC and a handful of transistors and is ideal for any audio work.
Many people have heard of a circuit known as a Voice operated relay or VOX. Theses use your voice input to close a relay which then is used to switch on a light or an amateur audio transmitter.
This circuit differs slightly in that it doesn't switch a relay but it switches the audio output on and off.
Whenever you speak, the CMOS switch closes and stays closed for about 5 seconds after you stop speaking. This is ideal for transmitters where the ordinary VOX would give you "hash" noise whenever the transmitter was switched off and on.
• Silicon Chip March '94.
Please call for price and availability.

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K10045	ETI 480 100W AMP	$34.95
K10050	ETI 480 POWER SUPPLY	$28.95
K10055	GENERAL PURPOSE PRE-AMPLIFIER	$14.95
K10060	BALANCED MICROPHONE AMPLIFIER	$12.95
K10065	GENERAL PURPOSE AMPLIFIER	$14.95
K10070	BALANCED INPUT DIFFERENTIAL PREAMP	$19.95
K10075	FLOAT NICAD CHARGER	$14.95
K10080	TRANSISTOR TESTER	$22.95
K10085	300W PLAYMASTER AMP	$119.00
K10095	2 TONE ALARM	$9.95
K10100	1.5V TO 9V DC CONVERTER	$13.95
K10105	3 DIGIT COUNTER	$23.95
K10110	ELECTRIC FENCE	$23.95
K10115	ELECTRIC FENCE CONTROLLER	$61.95
K10120	TV PATTERN GENERATOR	$109.00
K10125	UNIVERSAL POWER SUPPLY	$12.95
K10130	DISCO LIGHT	$165.00
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K10370	PORT. 12V LEAD ACID BATTERY CHARGER	$27.95
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Construction project:

New high-performance Playmaster power amp — 2

In this second and final article describing the Pro Series Three amplifier, we provide full construction details and cover its very simple set-up procedure.

by ROB EVANS

Thanks to design changes made to accommodate the new TO-3P MOSFETs, the Pro Series Three's new amplifier module and heatsink arrangement are even simpler than those used in its predecessor, the Pro Series One. While this amp was already much simpler to build than many of the comparable older designs, you should find that the new design goes together in an even more straightforward manner.

As you can see from the photos of the prototype though, the amp has quite a different internal layout to that of the Pro Series One, and consequently its case has a more compact front profile — but with an increased depth.

In its completed form, the new amp measures 400mm x 80mm (front panel) x 300mm (depth), and weighs in at around 7kg. So the Pro Series Three is not a lightweight amplifier, in any sense...

Its internals are arranged in a symmetrical format where the two heatsink and amp module assemblies act as the sides of the box, and the toroidal power transformers occupy the remaining centre area, where each is attached to the bottom panel by a large single bolt. In keeping with this simple arrangement, the bridge rectifiers are also bolted to the bottom panel of the box, all plugs and sockets are fitted to its rear panel, and only the main power switch and clipping LEDs occupy the front panel.

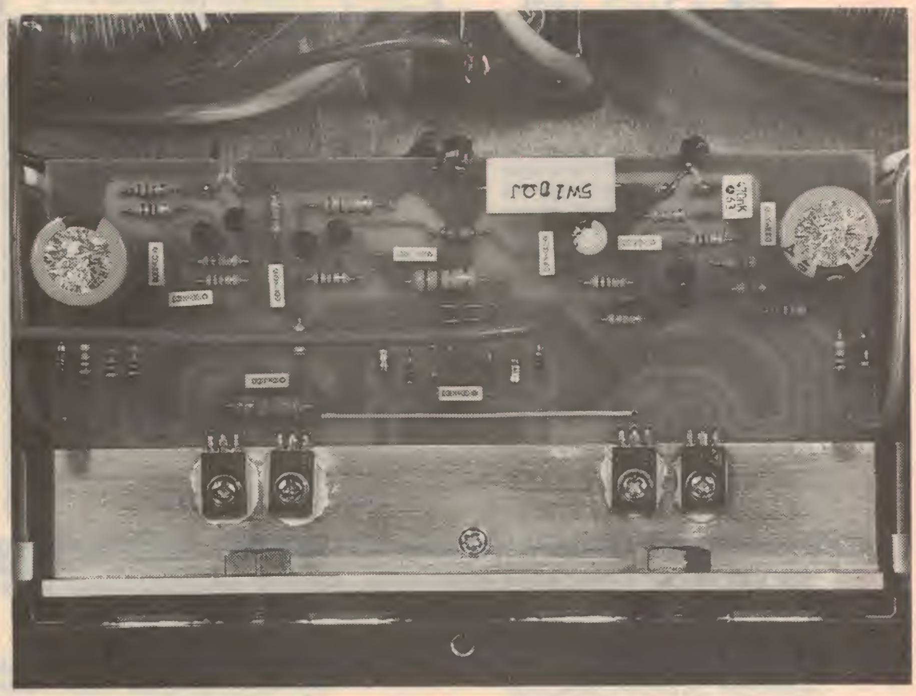
As before, the amp's construction process can be broadly divided into two tasks: putting together the module/heatsink assemblies, then completing the box and its associated wiring. Note that there's a logical order in which each construction step should be completed, and inexperienced constructors in particular should work though the following assembly instructions and tips in sequence — this should ensure that each area of the amp is accessible at the appropriate time.

Module/heatsink assembly

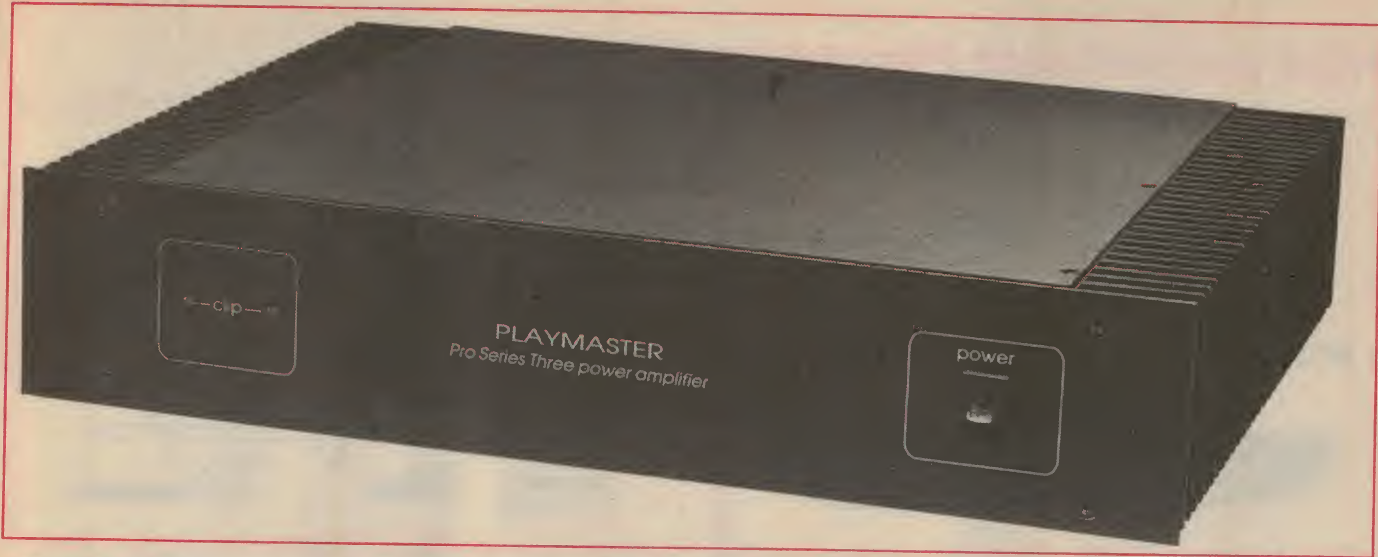
Start this part of the construction by fitting all components to the PCB (coded 94ma2, with dimensions of 79 x 140mm) as shown in the *component-side* overlay diagram, with the exception of the driver transistors Q5 to Q8, and the power MOSFETS Q9 to Q12 — the parts shown on the *copper-side* overlay diagram are fitted at a later stage. As usual, start with the lower profile components (resistors, PCB pins, etc) and work your way up to the larger parts (C14 and C16), while paying particular attention to the orientation of any polarised components.

Don't forget to install the long wire link between R11 and Q5, and the two short links near the centre of the board (next to R22), as shown on the overlay diagram.

The long link should be formed with light-duty insulated wire, while the short links can be completed with either 22g tinned copper wire or just offcuts from a 5W resistor's legs — such as R31. Other than that, make sure that the two 100uF electrolytics are mounted fully down onto the PCB surface and can't be rocked from side to side, and check that you've correctly identified zeners ZD1 and ZD2 over signal diodes D1 and D2.

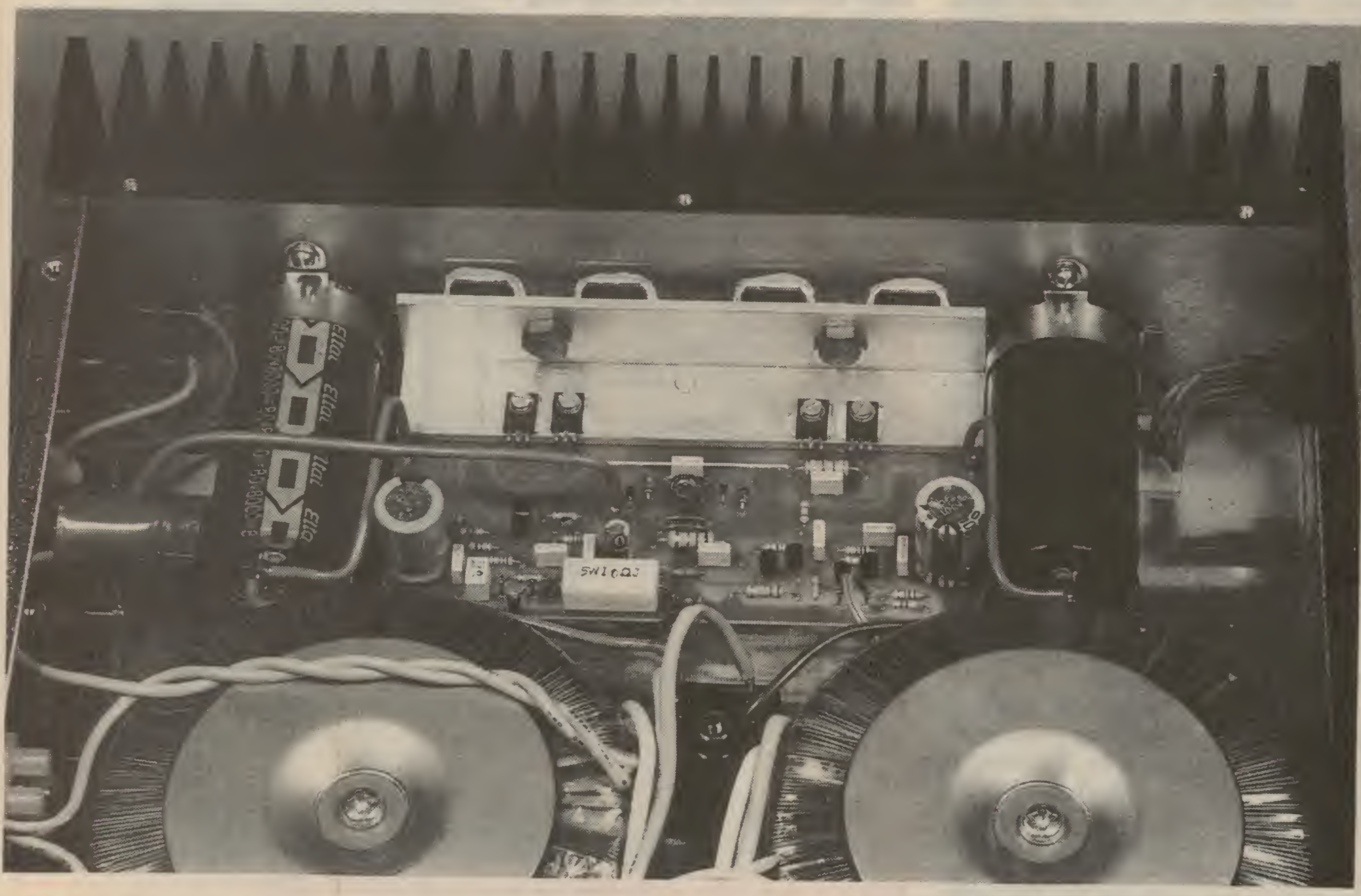


The new compact amplifier modules are very easy to assemble and install. The small aluminium bracket locates the PCB, acts as heatsink for the driver transistors, and clamps the MOSFETs to the heatsink via two large bolts.



If you have a transistor tester at hand, or have the patience to build a simple test circuit, you may like to match the parameters of the two BC556 input transistors (Q3 and Q4), as this will enhance the amp's performance to some degree — specifically, it will give a slightly lower high-frequency distortion figure, and a reduced output offset voltage. Since there are eight of these transistors needed for the complete amplifier (four per module), it shouldn't be too difficult to isolate a pair for each module which have close h_{FE} (current gain) and Vbe (base-emitter voltage drop) figures. Note that the pairs really don't have to be an *exact* match; just choose two which have the same 'ballpark' figures.

Once you are happy with your choice of transistors, Q3 and Q4 can be fitted to the PCB as a thermally coupled pair, so as to minimise the the amplifier's offset voltage drift with changes in ambient temperature. Here, smear the flat section of each transistor's face with a small amount of thermal grease, then align and solder the devices in place so that the two surfaces are in parallel contact. As with the above case, this 'fine-tuning' process will only have a minimal effect of the amplifier's final performance, and the step can safely be skipped if you don't have the time or inclination for such



The amp's internals are quite neat and uncluttered, with very little interwiring needed — note how the main filter capacitors mount directly to the heatsink, on either side of the module.

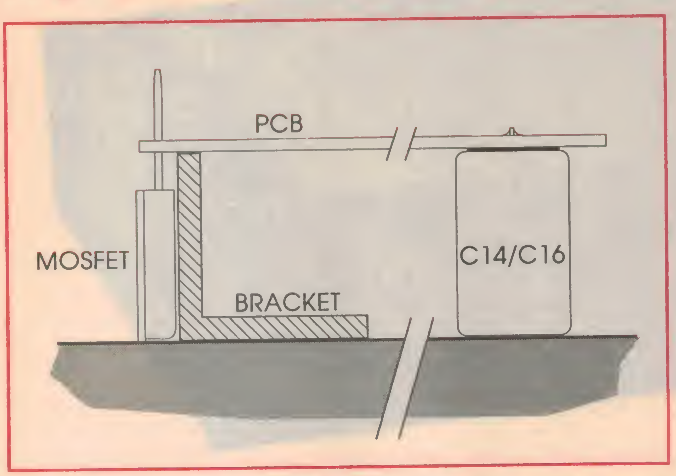


Fig.1: Use this temporary arrangement to align the MOSFETs as their legs are soldered to the PCB pads.

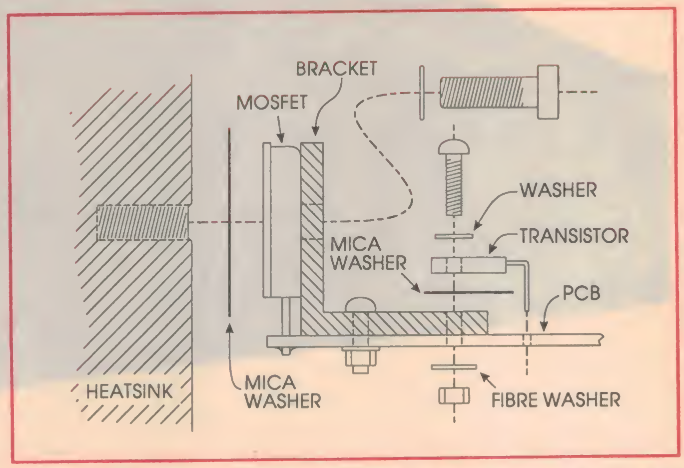


Fig.2: Use this diagram as a guide when fitting the bracket and TO-126 driver transistors (see text).

refinements — in which case, the transistors can simply be installed in the usual isolated manner.

Also note that the PCB has been designed with (mostly) the small MKT-style capacitors in mind, and the more traditional metallised polyester ('greencap') devices may be too large for many locations on the board. In short, 100V MKT capacitors are highly recommended, with the exception of C1 which can have the more common 63V rating (a *100V* 0.47uF MKT would be too bulky to fit in that location).

On the other hand, it may be convenient to use a 'greencap' type for the 0.1uF bypass capacitor C7 which spans the board's large central earth track, as the wider lead spacing is more suited to that component's PCB pads. If you end up using an MKT-type (as was the case with our prototype boards), just splay the legs with a couple of sharp bends so that the capacitor fits neatly into the holes for C7.

As a final point regarding this part of the board assembly, and for that matter all of the remaining construction, we should emphasise the importance of a sound soldering technique and its effect on the quality and reliability of the completed amplifier — unfortunately, many an otherwise well-assembled project has been let down in this regard.

These problems tend to come to a head where heavy duty wires are involved or component leads must be connected to large PCB tracks — which tends to be the case in this type of amplifier project.

So at the risk of boring experienced constructors, we would suggest you check that your soldering iron has sufficient heating capacity for the job, and that the solder at these potentially troublesome joints has flowed smoothly between the two surfaces and does not have that telltale dull 'dry' look.

On the other end of the scale, take care not to overheat the small ceramic capacitors (such as C6) whilst they are being soldered in place, since they have been known to completely fail under these circumstances while showing no visible signs of damage.

The next job is to fit the remaining parts to the PCB, including the aluminium mounting bracket — and once again, the order of assembly is important.

Start this task by fitting the four power MOSFETs (Q9 to Q12) into the board while using the mounting bracket as a height guide, as shown in Fig.1. Here, the PCB is placed on a flat surface with the component side down, so that one side is propped up by the 100uF filter capacitors C14 and C15 (ours were just the right height) and the remaining MOSFET side

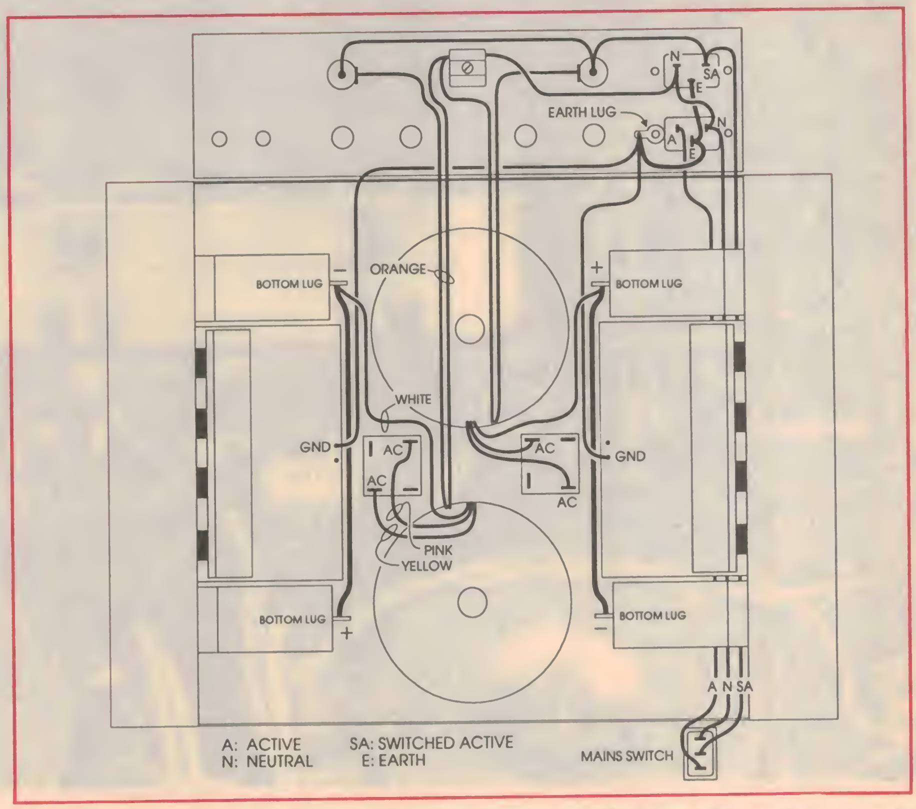


Fig.3: The amplifier's AC-wiring diagram, looking from above. Follow this closely when completing the AC wiring as detailed in the text.

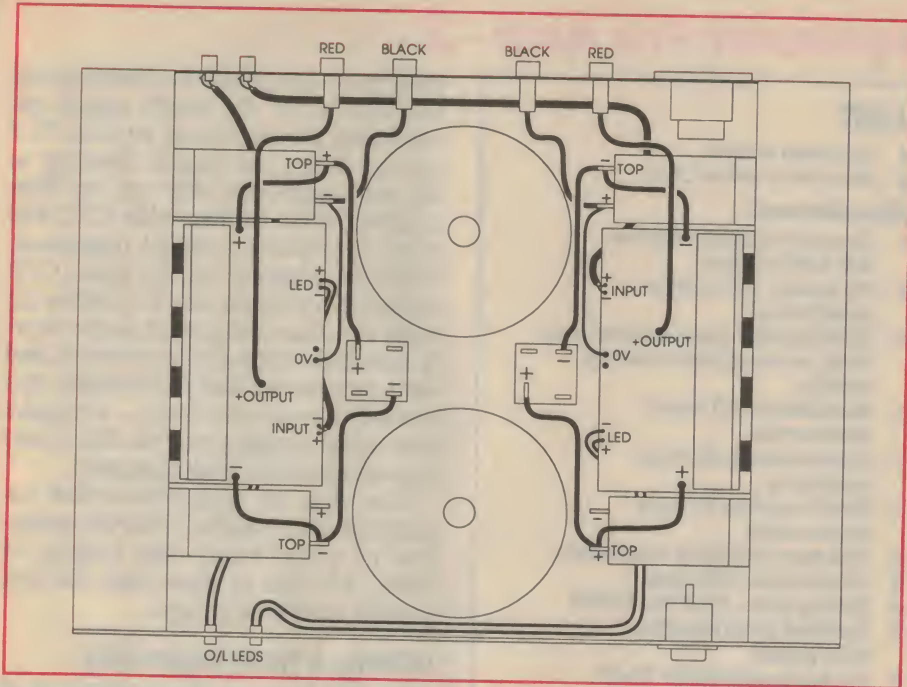


Fig.4: The amplifier's main signal interwiring. Note that with the exception of the shielded input leads, the heavy lines shown here (and in Fig.3) represent heavy-duty cable.

is supported by the loose bracket, which should be positioned as shown.

The MOSFETs can then be aligned to both the flat surface and the mounting bracket, and then soldered in place — the result should be a row of MOSFETs that are both perpendicular to the PCB, and at the same 'height' above it. Note that each MOSFET's metal face is facing *away* from the bracket.

After checking that the mounting holes in the bracket accurately match those of the PCB and heatsink, it can be attached to the board by just the centremost mounting screw at this stage. Provided that the four remaining holes are correctly aligned, you are now ready to install the flat-pack (TO-126) driver transistors Q5 to Q8.

These devices should be installed as shown in Fig.2, and in the order shown in the component-side overlay diagram — note that the two *MJ340* transistors are on the *left* side of the module. They are all bolted to the bracket and PCB via insulating (mica) washers, which should have both surfaces coated with a smear of thermal grease, and have their leads bent at a reasonably sharp right angle as shown — this ensures that the legs will clear the edge of the bracket. Also note that these transistors are installed with the metal face down towards the bracket, and each mounting bolt is fitted with a fibre insulating washer under the nut, which guarantees its electrical isolation from the nearby PCB tracks.

Once you are happy with the driver transistors' installation, use a multimeter to check that their collectors (centre pin, and the body's metal face) are electrically isolated from the bracket, then finally solder the leads to the PCB. This soldering should really be done as the *last* step, as this will avoid the strain on the leads and PCB tracks which would occur if the bolt was tightened after the soldering process.

Next on the agenda is attaching the completed amplifier module to the heatsink. This is a very straightforward process, and involves a couple of large screws which should have matching threads tapped into the flat surface of the heatsink, as also shown in Fig.2.

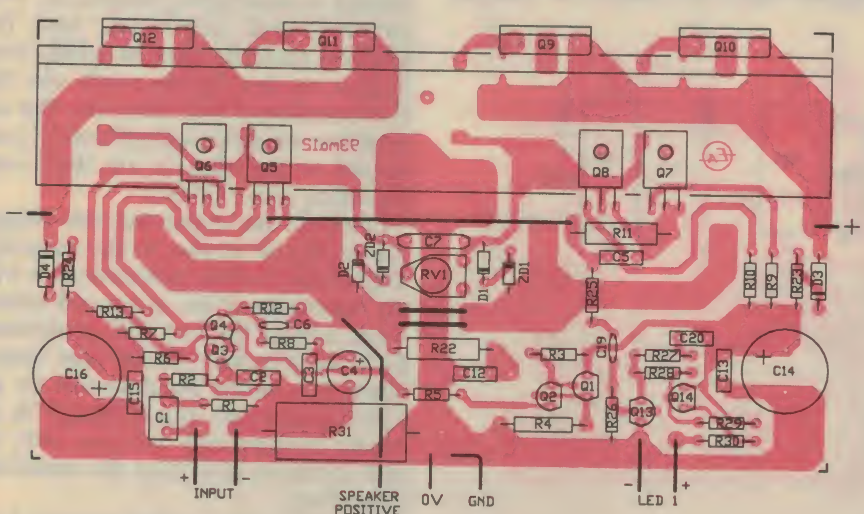
First, check that the heatsink face is reasonably flat and smooth, and if necessary clean up the surface with a suitable piece of emery paper, as any sharp protrusions could penetrate the MOSFET insulating washers. Then the whole assembly can be bolted together, with a layer of thermal grease applied to both sides of the TO3-P insulating washers.

Before you fully tighten the two mounting bolts though, double check that the insulating washers are properly aligned to the MOSFETs, as they tend to slide about on the heatsink face while the two assemblies are brought together.

When you're happy with this, tighten the mounting bolts and as a final check, confirm that the end of the PCB is not *quite* touching the heatsink face — if all's well, there will be a gap of about 1mm between the two.

The remaining parts can now be fitted to the copper side of the PCB, as shown in the copper-side overlay diagram. The best method here is to lay the whole assembly on the bench with the heatsink fins facing away, while looking at the copper side of the board (of course). Then progressively fit the components working from one side to the other, so that there is always access room for the soldering iron barrel — if you hold the iron in your right hand for example, work from the left-hand side of the board to the right. Since most of the components involved will end up spanning tracks on the board, they will need to be mounted in a slightly elevated position, and should have their leads shaped accordingly.

This is particularly important for the 5W resistors, since the air gap between their bodies and the PCB tends to aid the cooling process, and in this case should



The overlay diagram for the component side of the PCB. Carefully follow this layout when assembling the amplifier modules.

PARTS LIST

Resistors

(All 0.25W 5% unless noted) 2 x 1M, 2 x 330k, 2 x 100k, 2 x 82k, 4 x 33k, 2 x 22k, 2 x 5.6k, 4 x 4.7k, 6 x 1k, 2 x 680 ohms, 8 x 220 ohms, 10 x 100 ohms, 4 x 10 ohms (setup resistors)
2 x 22k 0.5W, 2 x 8.2k 1W, 2 x 10 ohm 5W, 2 x 6.8 ohms 1W, 8 x 0.22 ohms 5W 2 x 200 ohm miniature horizontal-mounting trimpots

Capacitors

- 4 8000uF 80VW chassis-mount electrolytics
- 4 100uF 100VW PC-mount electrolytics
- 2 47uF 16VW PC-mount electrolytics
- 4 0.47uF 100VW MKT or similar
- 2 0.47uF 63VW MKT polyester
- 12 0.1uF 100VW MKT polyester
- 2 22nF 100VW MKT polyester
- 4 10nF 100VW MKT polyester
- 2 1nF 100VW MKT polyester
- 2 47pF ceramic
- 2 18pF ceramic
- 2 10pF ceramic

Semiconductors

- 4 2SK1058 power MOSFETs
- 4 2SJ162 power MOSFETs
- 4 MJE340 transistors
- 4 MJE350 transistors
- 2 BC546 transistors
- 10 BC556 transistors
- 2 3504-type 35A diode bridges
- 4 1N4002 diodes
- 4 1N914 diodes
- 4 12V zener diodes
- 2 5mm red or yellow LEDs

Miscellaneous

- 1 Case with integral heatsinks, 400 x 300 x 80mm
- 2 PC boards, 140 x 79mm coded 94ma2
- 2 300VA toroidal power transformers, 100V centre-tapped secondary winding
- 1 Illuminated SPST mains rocker switch
- 1 Panel mounting IEC-type mains plug
- 1 Panel mounting IEC-type mains socket
- 2 3AG panel mounting fuse holders
- 2 3A slow-blow 3AG fuses
- 4 Binding posts, 2 red and 2 black
- 2 Insulated panel mounting RCA sockets
- 8 Insulating washers for TO-3P MOSFETs
- 8 Insulating washers for TO-126 transistors
- 8 Small fibre washers to suit mounting bolts for TO-126 transistors

Solder lug, mains-rated terminal strip, mains-rated hookup wire, heavy-duty hookup wire, light-duty hookup wire, shielded audio cable, heatshrink or cambric tubing, stick-on rubber feet, cable ties with self-adhesive mounts, PCB pins, heatsink compound, nuts, bolts, lock-washers, etc.

be around 2mm. Once again, make sure that you don't overheat the small ceramic capacitors, and take particular care with the solder joints on the large PCB tracks.

The final step to complete the module/heatsink assembly is fitting the two 8000uF/80V reservoir capacitors to each heatsink. These simply mount straight onto the heatsink surface at either end of the amplifier module via their own mounting brackets, and are held in place by small screws which again, have matching threads tapped into the body of the heatsink.

Note that each capacitor should be aligned within its bracket so that the polarity of the uppermost connecting lug matches that of the nearby supply rail connecting pin on the amp module. So if you are facing the module (heatsink at the rear, component side up), the filter capacitor of the left-hand side (C22) will have its *negative* terminal uppermost, while the capacitor on the right (C21) should be positioned with its *positive* lug at the top. This arrangement can be clearly seen in the shots of the prototype, and we'd recommend that you compare this carefully to your own work — a mistake here would certainly cost the life of one or more expensive filter capacitors.

Now that the module/heatsink assemblies are complete (with the exception of a few heavy-duty lengths of cable), it's time to move onto the box assembly and wiring stage.

Wiring & final assembly

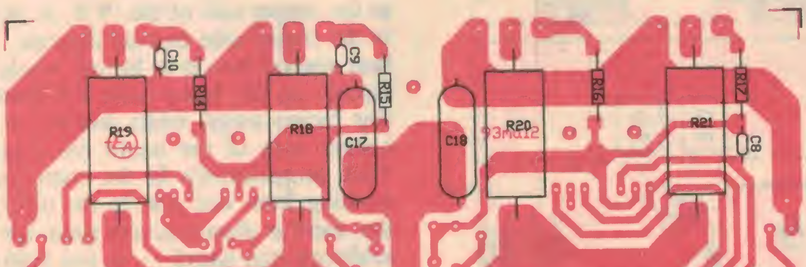
Begin this process by installing all of the appropriate parts into the rear panel, using the shots of the prototype as a guide. Don't forget to include the main earthing lug under the left-hand mounting bolt for the IEC mains input socket, and make sure that the RCA input sockets are electrically isolated from the metalwork.

The rear panel can then be attached to the large bottom panel, and the mains wiring completed. Note that for access purposes, the transformers, bridge rectifiers, and the module/heatsink assemblies are not installed at this stage.

At the risk of boring experienced constructors yet again, we cannot stress the safety aspect the 240V AC wiring too strongly. All exposed points which may be at mains potential (including the neutral connections) should be well covered and insulated, and the amplifier's chassis must be solidly connected to the mains earth via the abovementioned lug. Also note that the amplifier modules are ultimately connected to the chassis via their own grounding wire ('GND').

Complete the mains and low-voltage AC wiring as shown in the assembly diagram Fig.3. Take particular care with the orientation of the active and neutral wires around the two IEC connectors, since the pin order on the plug (mains input) is a mirror image to that on the socket (mains out). This is depicted in the wiring diagram, and with any luck, the pins should be labeled on the connectors themselves.

The three wires which connect from the IEC connectors to the power switch should be neatly fixed to the bottom



The component overlay diagram for the copper side of the PCB — install these components last, after the bracket has been attached to the PCB.

of the case by some convenient method (we used cable ties with self-adhesive mounting pads), and the remaining neutral wire terminated in a small section of insulated terminal strip as shown. Note that both the power switch and transformer primary leads will be connected at a later stage.

Since the inside of the rear panel is still quite accessible at this point, the next logical step is to connect appropriate cables to the input sockets, output binding posts, and the main earth lug. These will ultimately terminate to the heatsink/module assemblies as shown in Fig.4, which can be used to judge what length of cable is required for each connection. As you would expect, the input leads must be formed with shielded audio cable, and the speaker wiring completed with heavy-duty hookup wire.

The power transformers and bridge rectifiers can now be bolted to the bottom panel, and the transformer's primary and secondary leads connected as shown in Fig.3. Take care not to let the weight of the transformers warp the bottom panel during this procedure, as its sides are not yet supported by the heatsinks.

Next, complete the interwiring on each module/heatsink assembly as shown in Fig.3 and Fig.4. This includes the power supply leads which connect the uppermost capacitor lugs to the PCB (heavy-duty wire, Fig.4), the main 0V link between the lower capacitor lugs (heavy-duty wire, Fig.3), and the PCB's 0V reference lead which terminates at the bottom lug of the rearmost filter capacitor (standard wire, Fig.3).

As you can see from the connection diagrams and shots of the prototype, the module's various 0V lines come together at the lower lug on the capacitor which is nearest the rear of the amp, with the exception of the earthing wire ('GND') and the input signal ground. This is effectively each module's central earth point, and is an important arrangement for maintaining the amp's performance and stability. So while soldering a number of heavy wires to a single capacitor lug can be a little awkward, don't be tempted to change the layout for one that's more conducive to easy soldering...

Each module/heatsink assembly can now be hooked-up, then fastened to the bottom panel. The best method here is to place the assembly slightly away from its final mounting position so as to gain space for soldering iron access, connect the remaining free wires as shown in Fig.3 and Fig.4, then bolt the unit in place.

Finally, the front panel can be bolted to the heatsinks, and the mains switch and overload LEDs installed as shown — use light-duty hookup wire for the LED wiring, and don't forget to insulate the exposed switch terminals. Note that the mains switch has three lugs, with two identified by small wires looped around their bases (one of these is the centre lug). The neutral (N) wire connects to the *outer* of these two lugs, while the switched active (SA) wire connects to the centre lug. The incoming active (A) wire connects to the remaining outer lug.

Tidy up the wiring, while double checking that all connections are correct, and fit a set of rubber feet to the bottom panel. Note that the feet should be positioned well in from the edges of the box, as most of the amp's mass is due to the centrally-mounted power transformers.

Powering up

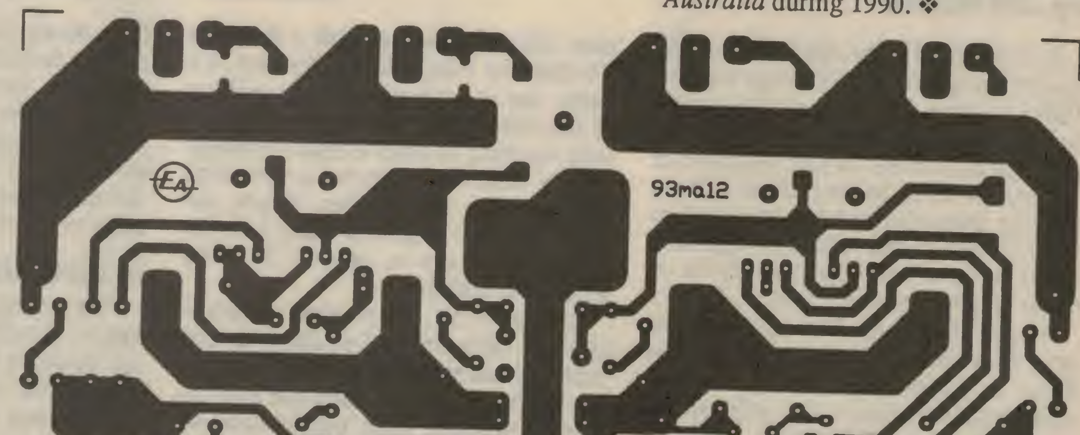
Before applying power to the amplifier, rotate each module's bias trimpot (RV1) fully *clockwise* for a minimum quiescent current setting, and temporarily fit a 10-ohm resistor in series with each power supply rail — the most convenient position is at the PCB stakes on the ends of the modules. Then apply power to the unit and confirm that the supply rails measure around +/-75V, and the amp's output voltage is very close to 0V (say +/-30mV).

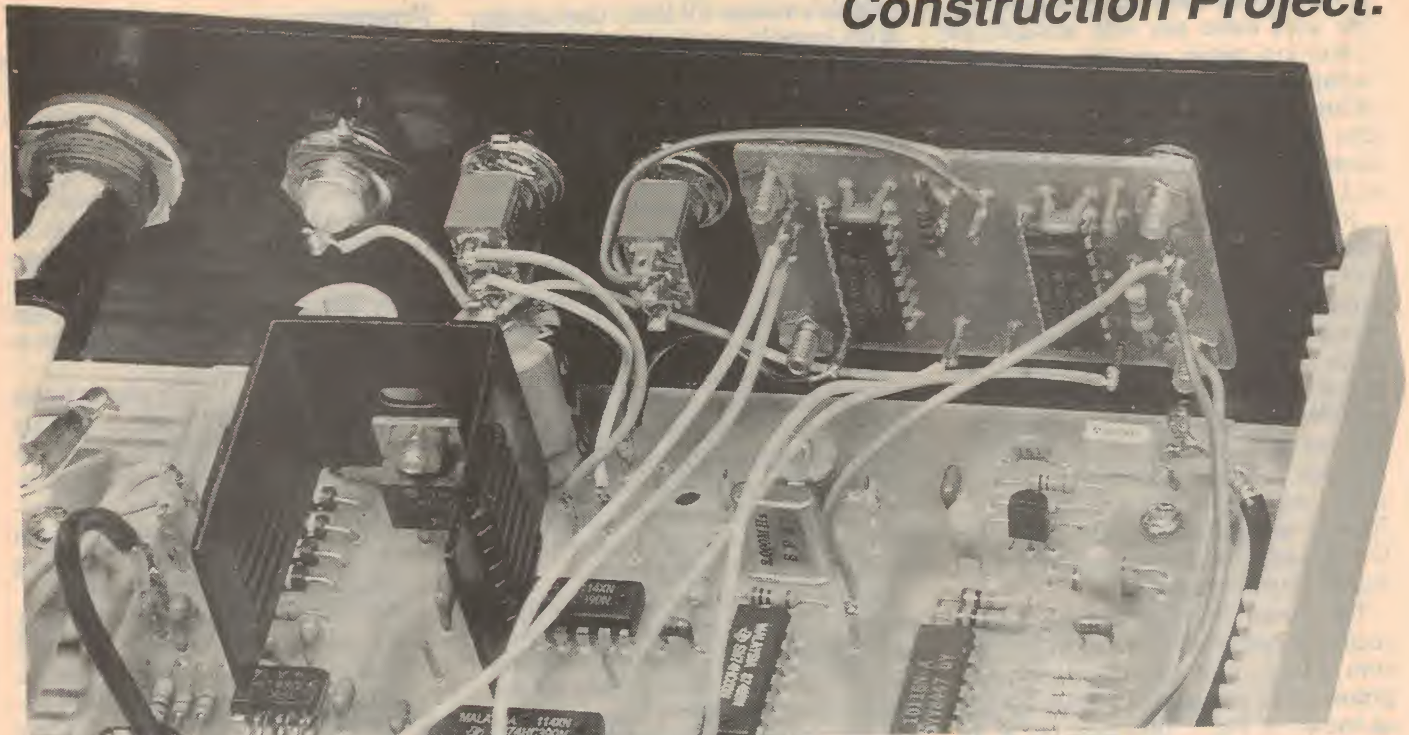
If one or more of the 10-ohm resistors immediately goes up in smoke, quickly turn the amp off and double-check your work — because you'll have made a mistake... But of course this won't have occurred(!), so you can now set each channel's quiescent current by reading the voltage across the test resistors.

While the standing current in this design is not particularly critical (beyond a minimum amount), we'd recommend a reading of about 0.8V for each module; this represents a current of around 80mA. While this figure will tend to rise as the amplifier warms up (say, due to delivering a significant level of output power), the MOSFET's negative temperature coefficient (NTC) effect comes into play at standing currents above about 100mA, where the output stage will tend to thermally self-stabilise.

That's about it. If you feel that you need more information on installing or faultfinding your new amp, we'd recommend that you check out the second and third instalments of the original Pro Series One article, which were published in the January and February issues of *Electronics Australia* during 1990. ❖

And finally, we show the PCB pattern actual size as usual, for those who wish to etch their own board.





HI-RES MOD FOR THE 1GHZ COUNTER

Here are the details of a simple modification for our low cost 1GHz Frequency Counter of April 1993, to allow it to make use of the TV-Derived Frequency Reference (October-November) as a precision timebase. As well as providing the counter with an external timebase input, the modification also provides a second set of measurement ranges with 10 times the resolution of the existing ranges.

by JIM ROWE

As I explained in the April 1993 article, the design approach taken with the new 1GHz counter was one of deliberately leaving out 'frills' and features that are rarely used, in order to keep the price of the project down to an attractive level. Judging from the number of kits that seem to have been sold, that approach seems to have been vindicated as far as many builders are concerned.

As part of this no-frills approach, we gave the counter a display of only seven digits, as higher display resolution isn't really justified when you're only using a simple crystal oscillator as the timebase.

We were also able to cover the frequency limits of the instrument in just four ranges, with only two gating times: one second for the three lowest ranges, and 512ms for the pre-scaled 1GHz range. However now that we've also been able to come up with a low cost TV-Derived Frequency Reference, it's likely that at least some of the builders of the counter will want to use the two units together, in order to take advantage of the reference unit as a precision timebase for the counter. Hence the reason for this article, to show how the basic counter can be adapted for more accurate counting.

As it turns out, the required modifications are fairly straightforward. Only two extra ICs and a handful of small parts are needed, to give the counter not only an external timebase input, but a second set of four ranges which allow it to take advantage of the greater accuracy of the TV-derived reference, via enhanced counting resolution.

The modification does not involve changes to the counter's front panel, and even results in the extra ranges having correct decimal point indication on the display — to minimise the possibility of reading errors.

And the really good news is that the all-up cost of the modification should be no more than about $25, plus a couple more hours of your time!

In more detail

First up, let's see how it's done. Very little is actually needed to add the external timebase facility, because in the pattern for the main PCB of the counter I had already allowed for it. Pin 13 of divider chip U3 was not joined directly to pin 12 under the IC; instead, tracks from each were taken to a pair of pads near the back of the board, with a short track linking the two there. Both pads were intended to take PCB terminal pins,

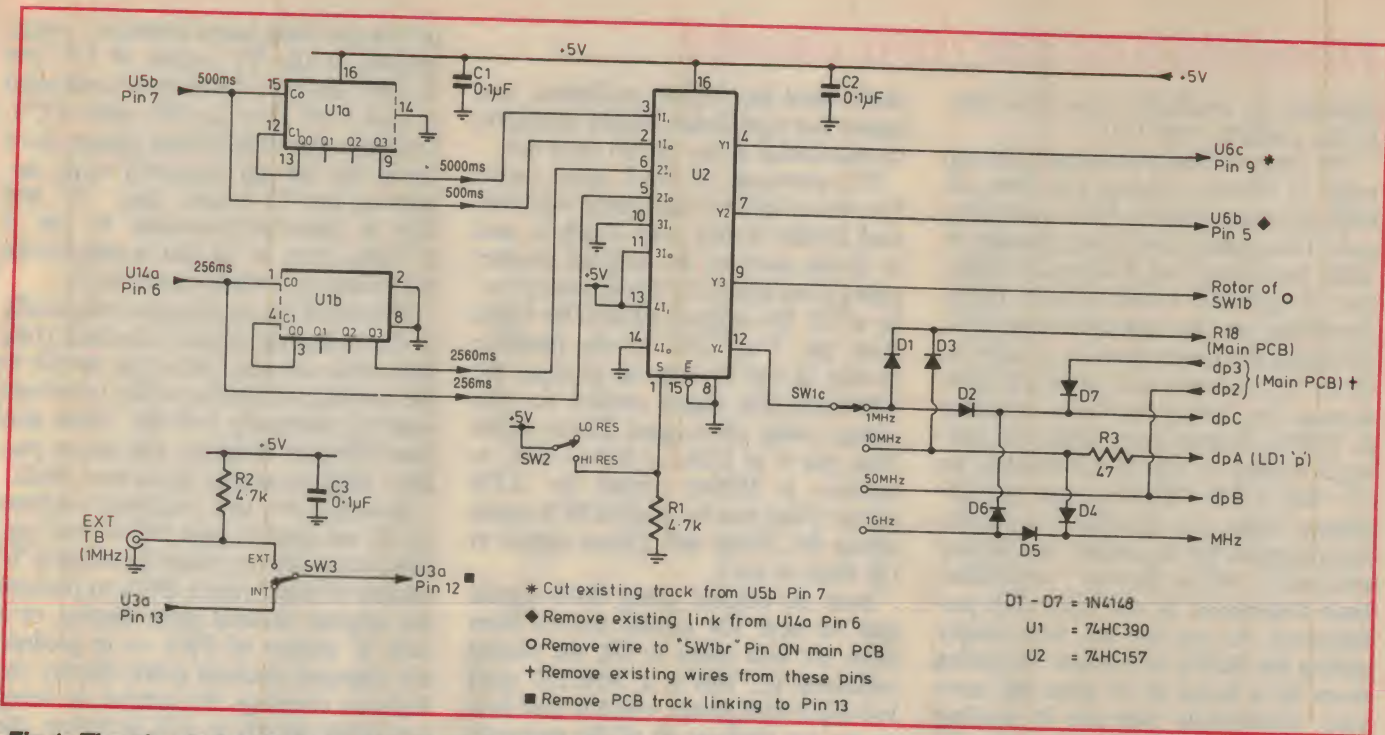


Fig.1: The circuit details for the counter modifications. All of the extra circuitry fits on two very small PC boards, one of which fits inside the back panel as shown opposite. The other board fits behind the front panel, supported by the wiring behind the range switch. The two additional switches and external timebase socket are also visible in the photo opposite.

although in the basic design as described it only made sense to fit *one* — to provide access to the 1MHz signal derived from the internal crystal oscillator, if desired.

What this means, though, is that adding the external timebase facility is now simply a matter of cutting the track under the PCB which links the two pads, fitting a PCB pin to the second pad, and then connecting them to a miniature SPDT toggle switch and BNC socket mounted on the rear panel. The connections are as shown in the lower left of the schematic in Fig.1.

As you can see, in the 'INT' position the new switch SW3 simply connects the two together again, to allow operation from the internal timebase. But now it can also be switched to the 'EXT' position, allowing pin 12 of U3a to be fed with 1MHz signals from an external source — such as the TV-derived reference.

Resistor R2 is used to pull the pin 12 input of U3a up to logic high if the external timebase is disconnected with the switch in the 'EXT' position, to prevent spurious oscillations, and also to make the external timebase input compatible with TTL-type sources as well as CMOS.

Now let's look at the main part of the modification, which is to allow the counter to make measurements with increased resolution — so it can take advantage of the higher timebase accuracy.

Ideally, perhaps, one would like to add an extra digit or two to the counter's display, to increase its overall resolution. However this would involve major changes, including an entirely new display board and even a 'transplant' of the counter works into a larger case. Hardly a minor modification!

As it happens, though, a worthwhile increase in reading resolution can be achieved even if we retain the original seven-digit display. This is because the seventh digit was really only a 'partial' digit in the original design, because of the range scaling. If we accept a few changes in terms of full-scale reading on some of the ranges, we can get an effective 10-times increase in resolution for most measurements, with the same seven-digit display.

Essentially what is needed, to increase the counting resolution of this type of simple counter, is to extend the gating times by a factor of 10. In other words, by counting for 10 seconds instead of one second for the lower ranges, and for 5.12 seconds instead of 512ms for the top range. This allows 10 times as many signal periods to be counted, and gives a potential 10-times increase in reading resolution.

Of course one penalty we pay, for doing this, is that each measurement takes 10 times as long to make. You can only make one measurement every 20 seconds in the case of the lower ranges, and one every 10.24 seconds on the top range. But this tends to be inevitable when you're making higher resolution measurements with most counters (all except the 'intelligent' variety, in fact), and is normally regarded as an acceptable trade-off when you're making this kind of measurement.

The other penalty we pay is that, if we don't have additional counter stages and display digits, our longer gating times mean the counter tends to reach its full-scale reading at input frequencies 10 times lower than before. So this is where our limited display digits tend to have their impact.

In fact, though, it turns out that the limitations imposed by our seven-digit display are not severe. With 10-second gating, our original 2MHz lowest range can now still count to 999,999.9Hz — so it becomes a 1MHz range. Note that the reading resolution has increased by a factor of 10 (it now reads in 0.1Hz increments, instead of 1Hz), yet the full-scale resolution has only been halved.

Similarly, our original '20MHz' range changes into a 10MHz range (full scale reading 9,999,999Hz), again offering 10 times the reading resolution with only half the full-scale reading.

The situation is actually even better with the original '50MHz' range, which because of its 100:1 prescaling previously only gave six digits of resolution. With 10-second gating it can now give a full seven digits, reading in 10Hz increments and with an unchanged full-scale resolution (64.99999MHz, or

Hi-res mod for the 1GHz counter

whatever is available from your particular prescaler chip U2).

The improvement possible with the top range is almost as good, too. Here the original range with its 512:1 prescaling and 512ms gating time gives counting in 1kHz increments and a full-scale resolution of typically a little beyond 1GHz, depending on your prescaler chip U12. Changing the gating time by a factor of 10 to 5.12 seconds now gives the same increase in reading resolution (counting in 100Hz increments), while the full-scale reading is still 999.9999MHz. So it's still a full '1GHz' range, the difference being now that this is a definite limit imposed by the counter and display resolution, rather than an 'extendible' limit determined by the input chip performance. As you can see, then, simply adding the facility to increase the gating times by a factor of 10 gives the same very worthwhile increase in reading resolution, with only minor penalties in terms of the reduction in full-scale readings. The only real hassle is the slower rate of making measurements, because of the longer gating times themselves...

By making it possible to switch between the original and longer gating times, then, you can have the best of both worlds: faster measurements when you don't need the higher resolution, and slower but significantly higher resolution measurements when you do need this.

The schematic of Fig.1 again shows how this is done. An additional 74HC390 dual decade divider chip U1a/b is used to divide each of the original counter gating drive signals by the necessary factor of 10. The original 500ms/2Hz signal from pin 7 of U5b in the timebase divider is fed to U1a, to produce the 5000ms/0.2Hz signal needed for 10s gating, while the original 256ms signal from pin 6 of U14a is fed to U1b, to produce a 2560ms signal for 5.12s gating. (Note that the original PCB tracks taking the 500ms and 256ms signals to U6 must be cut.)

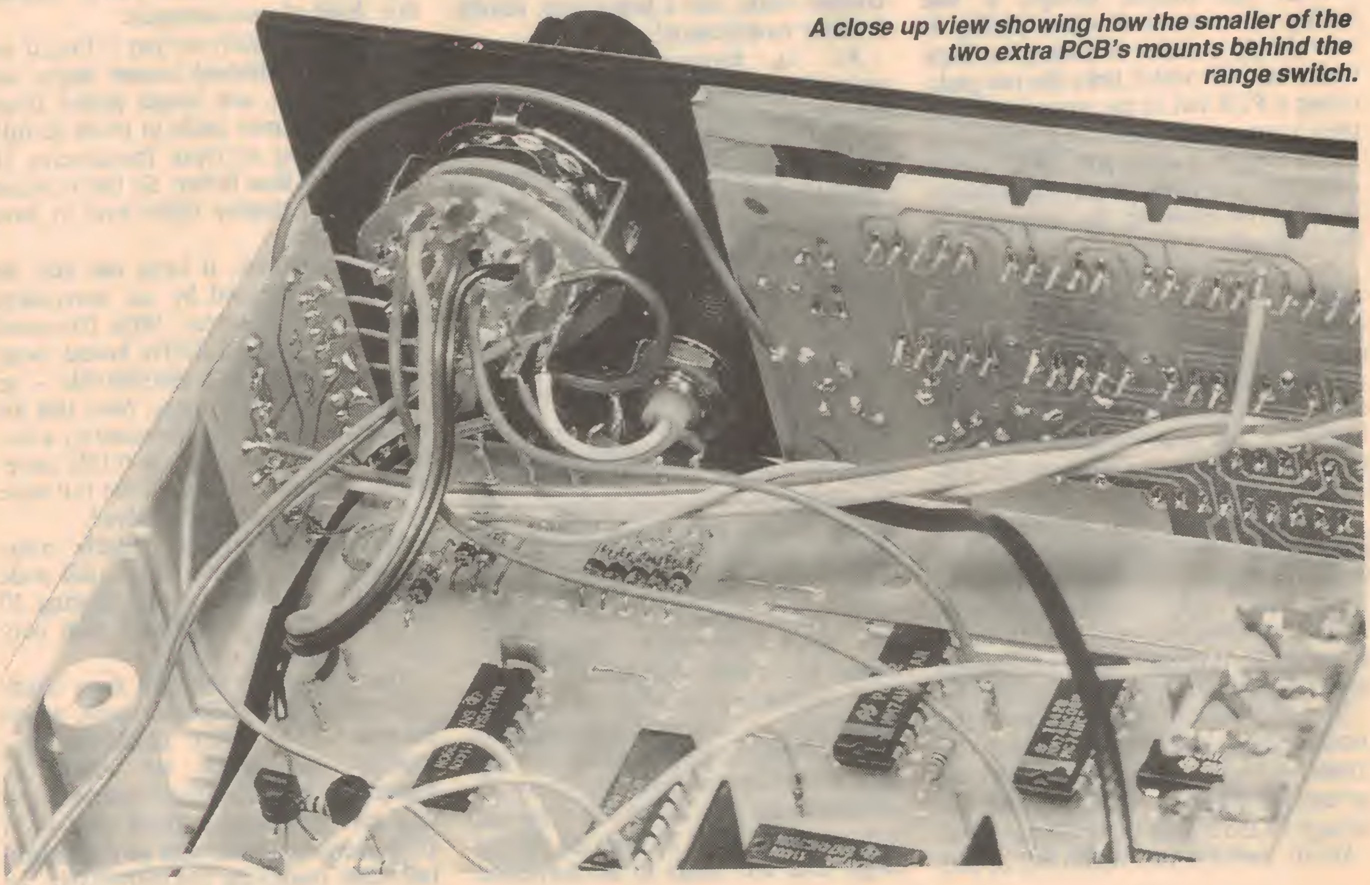
Both the original gating drive signals and the new 10x signals derived from them are then taken to U2, the second additional IC. This is a 74HC157 quad two-input multiplexer, which is used here so we can perform all of the necessary low/high resolution switching using another small SPDT toggle switch on the rear panel of the counter (SW2). SW2 simply switches the control input (pin 1) of U2 between 0V (= original low resolution) and +5V (= high resolution), and U2 does all of the real switching.

The 500/5000ms gating drive signal for the three lower frequency ranges appears at the Y1 output of U2 (pin 4), and this must therefore be connected to pin 9 of U6c on the main PCB. Similarly the 256/2560ms gating drive signal for the top frequency range appears at the Y2 output (pin 7), and this is therefore connected to pin 5 of U6b. This is all that is required for the gating time modification itself.

The rest of the modification is basically to ensure that the counter's decimal point indication changes when you switch to the new high-resolution mode, to prevent reading ambiguity and the errors this would tend to introduce, and also to perform range switching in the new mode.

Basically, the two remaining sections of U2 are used to gate DC control signals, which activate either the original 'b' section of range switch SW1, to produce the original decimal point display, or a new 'c' section of SW1 — to produce the changed decimal point display for high-res counting. So instead of being connected directly to +5V as before, the rotor of SW1b is now connected to the Y3 output of U2 (pin 9), and this now only delivers +5V when low-res counting is selected by SW2.

Similarly the Y4 output of U2 (pin 12) is connected to the rotor of SW1c, which controls additional wiring for the new high-res range switching and decimal



A close up view showing how the smaller of the two extra PCB's mounts behind the range switch.

point indication. (Note that if your original switch for SW1 only has two poles, you'll need to replace it with a three-pole four position unit.)

As you can see, the additional wiring involves only seven more low-cost 1N4148 (or 1N914) diodes, plus a resistor (R3) for connection to the originally unused decimal point LED on the 'a' display. Diodes D1 and D3 are used to perform the range gating selection, diodes D4 and D5 the MHz/kHz LED selection and D2, D6 and D7 the decimal point selection.

Construction details

Apart from the two miniature toggle switches and the additional BNC socket which mount on the rear panel of the counter, all of the additional parts and most of the wiring for the modification fit on two very small PC boards. One, measuring only 53 x 34mm and coded 94cm1a, supports the two extra ICs plus R1 and R2, and is designed to mount on the inside of the rear panel alongside the toggle switches. The other is even smaller (34 x 29mm, coded 94cm1b) and supports the seven diodes and R3; this is so small and light that it is easily mounted behind the range switch SW1, and supported by the wiring (see photo). Both boards are designed to take PCB pins for all of the off-board connections.

The wiring of the two boards themselves should be quite straightforward, if you use the overlay diagram and photos as a guide. Just take the usual care with the ICs and the diodes, to ensure that they're fitted the correct way around.

Once both boards are wired up, I suggest that you put them aside for a short time while you prepare the counter itself for the modification. The main task is to drill and ream the holes in the back panel, to take the additional BNC socket, two miniature toggle switches and 94cm1a PCB assembly. The last of these simply mounts via four 3mm diameter by 10mm long machine screws, with additional nuts used for spacing to clear the solder joints under the board (see photo).

By the way, *don't* try to drill and ream these holes with the rear panel still fitted to the counter's case. The risk of damaging the existing counter wiring is too great. Disconnect the wiring to the mains connector and fuseholder, which will allow you to remove the rear panel from the case before 'attacking' it. Then there shouldn't be any accidents, and it will only take a few minutes to re-assemble things when the holes are prepared.

In fact while you have the rear panel out in the open, you can easily fit the new BNC socket, the two miniature toggle switches and even the PCB assembly to it.

The next step is to remove the four screws holding the main PCB assembly inside the case, and swing it up carefully to allow you to perform the necessary 'minor surgery' on its underside. (When you're doing this surgery, take great care not to damage anything. Your soldering iron should be earthed to prevent damage to the ICs, for example...)

You need to cut the track joining U5 pin 7 to U6 pin 9, preferably at the short 'dog-leg' section about half way along its length. Then you can drill 1mm holes adjacent to the two ends of this track, and fit a pair of additional PCB pins — soldering their underside to the track in each case. These pins will be used to take the 500ms gating signal to the rear-panel PCB, and accept the switched 500/5000ms signal back from it.

Step two in the surgical procedure is to remove the long meandering link which originally took the 256ms gating signal from pin 6 of U14 back to pin 5 of U6, by unsoldering its ends. Then you can fit another pair of PCB pins to the two vacated pads, soldering them in place underneath. These will be used to take the 256ms signal to the rear-panel PCB, and accept the switched 256/2560ms signal back from it.

Step three is to cut the short track connecting the two '1MHz' pads just to the rear of U3, and fit a PCB pin to the second pad (or pins to both, if you hadn't fitted one before). While you're in this area of the board, fit a further PCB pin to the previously unused hole just to the rear of these pads, in the 'earth' copper. This will be used for the earth return of the rear-panel board, while the other two are of course used for the connections to SW3.

There's only one remaining step in this surgery on the main PCB. This is to drill a 1mm hole, and fit a PCB pin, in the +5V supply rail track between U1 and U6, to provide +5V for the rear-panel PCB. I drilled this hole exactly midway between pin 14 of U6 and pin 9 of U1, so it was in the centre of the wide track underneath. Needless to say the PCB pin is soldered underneath to the copper.

This completes the main board surgery, so the PCB assembly can be carefully lowered back into the case and the four mounting screws refitted. If you wish, the rear panel can now be laid, outside- face down, just behind the case, allowing you to add the wiring between the various rear-panel parts and the main PCB.

The connections to the small board should all be fairly clear from the overlay diagram. The wires from SW2 connect to the centre top of the board, while the 256ms and 500ms gating signals from the main board connect to the pins at upper left. The pin at lower left connects to the main board earth, while the two pins at lower centre connect to the gating inputs of U6 on the main board. The pin at lower right connects to the centre pin on the rear-panel BNC socket, while the remaining three pins on the right-hand end connect to the rotors of range switch SW1, and the +5V supply pin on the main board.

The modified rear panel should now be complete, and you should be able to swing it up and re-fit it into the case. You may also need to re-connect the wiring to the mains connector and fuse holder, if this hasn't yet been done.

The final phase of the conversion is to replace the range switch SW1 with a three-pole switch, if necessary, and fit the

PARTS LIST

Semiconductors

7	1N4148 or 1N914 signal diodes
1	74HC390 dual decade divider
1	74HC157 quad 2-input multiplexer

Resistors

2	4.7k 5% 1/4W metal film (R1, R2)
1	47 ohm 5% 1/4W metal film (R3)

Capacitors

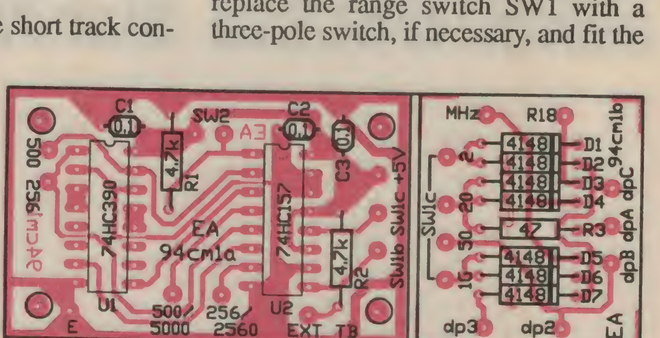
3	0.1uF monolithic ceramic (C1-3)

Miscellaneous

2	PC boards, 94cm1a (53 x 34mm) and 91cm1b (34 x 29mm)
2	Miniature SPDT toggle switches
1	BNC socket, single hole panel mount type
1	3-pole 4 position rotary switch (if not originally fitted)
29	PCB/matrix board terminal pins

Insulated hookup wire, tinned copper wire etc.

Use this overlay diagram as a guide to wiring both of the additional PCBs, along with the photographs.



second small PCB assembly (94cm1b) behind it. The details of this should be fairly clear from the photo and also the schematic of Fig.1. The PCB fits quite comfortably to the right of the switch (viewed from the front), orientated vertically and at 90° to the front panel, with the edge having the PCB pins which connect to SW1c nearest the front.

These pins connect to the appropriate switch lugs on SW1c, of course. If you use short lengths of 18g tinned copper wire for these connections, they'll easily hold the board in position.

The original wires running from pins 'dp2' and 'dp3' on the main counter board, to pads 'dpB' and 'dpC' respectively on the display board, should be disconnected from the main PCB pins and connected instead to the pins on the small PCB with the corresponding markings (i.e., 'dpB' and 'dpC'). Then an additional similar length of hookup wire should be used to connect the remaining 'dpA' pin on the small PCB to the previously unused 'dpA' pad on the display board, between display digits LD1 and LD2 and near their lower rows of pins.

Two short lengths of insulated hookup wire can now be used to connect the pins on the small PCB marked 'dp2' and 'dp3' to the pins on the main PCB just below, with the same markings.

All that remains is to connect the pins on the small PCB marked 'MHz' and 'R18', to their correct points using insulated hookup wire. The 'MHz' pin is connected to the copper track on the back of the display board, which connects to the pin of the same name at the bottom of that board. However the easiest place to solder the wire to this track is about halfway up the display board at the right-hand end (looking from the front), just below the pad at the bottom of R18. (The track concerned is vertical, and not the one at the very end of the display board, but the next one in.)

The 'R18' used to identify the other lead from the small PCB is NOT the one just referred to on the display PCB, but the resistor with that ID on the main PCB — located just to the rear of U10. And the lead from the 'R18' pin on the small

The two additional switches and BNC socket required for the modification mount on the back panel of the counter.

PCB must be soldered to the end of this resistor which is nearer to R15 — i.e., the right-hand end as viewed from the front of the counter. If you solder the wire to the resistor's pigtail very quickly but carefully with a hot iron, the job can be done without causing any damage to the resistor or disturbing its connection to the pad under the board.

Your modifications to the counter should now be complete, making it ready for testing. But just to make sure, give everything a final visual check to make sure you don't have any wires or pins that you've forgotten to connect.

Trying it out

Since the bulk of the modification is to provide for the longer gate times and their matching decimal point display, this is the area which is best checked out thoroughly.

First off, set rear panel switch SW3 for 'INT' and SW2 for 'LO RES' ('1 sec'), and apply on the power. The counter should now work in exactly the same manner as it did before the modification, so apply a suitable test signal and switch between ranges, checking that the correct readings are given and that the decimal point indications are the same as before. As you switch SW1 from the lowest range to the highest, decimal points D, B, C and D (again) should be activated in turn.

You should also find that new readings are made at the same rates as before: every two seconds in the case of the three lowest ranges, and every second or so for the top range.

If all seems well at this stage, switch SW2 to the 'HI RES' ('10 sec') position and check that as you now switch SW1 from the lowest range to the highest, decimal points C, A, B and C (again) are activated in turn.

If you try measuring a test signal, you should also find that two things are different. One is that the measurement rate is now 10 times slower — every 20 seconds for the three lowest ranges, and every 10.2 seconds for the top range. The other difference is that your readings now have an additional digit of resolution.

If everything is as described so far, the odds are that your modification has been successful. All that remains is to check the new external timebase facility.

To do this, connect the rear panel BNC socket up to the output of the TV-derived frequency reference — after the latter has been duly locked to a suitable rubidium-referenced TV signal, and set for 1MHz output. Then move the counter's rear-panel switch SW3 over to the 'EXT' position, so that the counter begins using this signal as its timebase instead of the 1MHz signal from its own crystal.

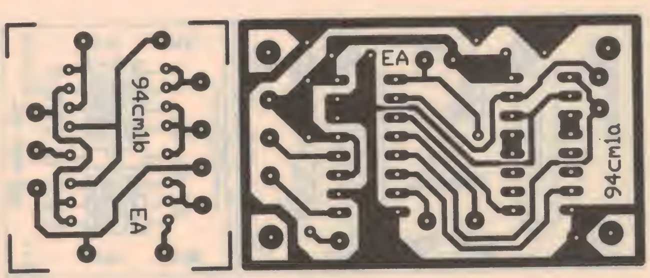
If all is well, the only thing you'll notice is that the readings you get change slightly, reflecting the difference between the internal crystal and the more accurate 1MHz derived from the TV signal. In fact if you connect the input of the 'A' input of the counter back to the '1MHz' pin at the rear of the main board (the one nearer U11, connected to pin 13 of U3), you will actually be able to *measure* the 1MHz from the internal crystal. You'll probably find it's a few hertz away from the correct value, and it will drift with temperature...

Needless to say if the results you have obtained during this checkout procedure have *not* been as described, this will almost certainly be due to wiring errors you've made. So analyse the symptoms carefully, and use them to track down the cause of the problem.

Otherwise, your counter should now be ready to use with the TV-derived frequency reference, to make measurements of improved resolution and accuracy.

Of course you can use the counter's new hi-res mode even with the internal timebase, although this makes less sense because of the lower accuracy available. Similarly you can use the original lo-res mode with the TV-derived external times, for making faster measurements which don't need the improved resolution.

You don't have to use the TV-derived reference as the external timebase, either. A higher-accuracy crystal oscillator (say one that is oven stabilised) in a signal generator, for example, could be used instead. The only requirement is that it can be set for 1MHz output, and has either CMOS or TTL output levels. ❖



As usual, these patterns for the two boards needed for the counter modifications are reproduced actual size for those who wish to etch their own.

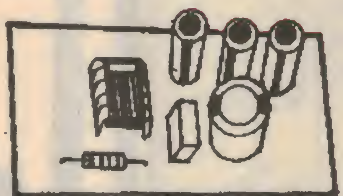
DICK SMITH ELECTRONICS

Make The Most Of These!

Kits To Suit Everyone - From Novices To Electronics Gurus!

A Big Noise From A Tiny Amp!

The Champ Mini Amp



You'll find this extremely tiny and inexpensive amplifier very handy for audio projects. Especially useful in projects where space is precious (it's even smaller than a 9V battery!), a single channel amplifier pumps 0.5W into 8 ohms with a 9V battery and with internal gain from 20 to 200. Comes with components and PCB only.

SILICON CHIP Feb'94

Cat K-5604 **$4.95**

Get Some Attention!

LED Chaser With 10 LEDs

This kit is ideal for store-front displays or any other place you want to draw attention to something. Its 10 LEDs flash in rotation around the outer edge of the board, speed adjustable by a trimpot. It's also a great way to learn a little about digital in the field. The kit comes in shortform with all components and PCB.

SILICON CHIP Feb'94

Cat K-3166 **$12.95**

Make Music With Your PC!

Low-Cost Midi Breakout Box

NEW

Do you have a soundcard in your PC? A must for all those interested in making music with their PC, this kit takes the place of those expensive MIDI (Musical Instrument Digital Interface) add-on modules that sound card makers sell you after you've already bought their sound card.......and discovered that you can't plug your keyboard direct into the card. It's also a whole lot cheaper than those "off-the-shelf" interfaces and is quite easy to assemble. Includes all neccessary components, PCB, hardware, case and pre-punched screened front panel.

EA March '94

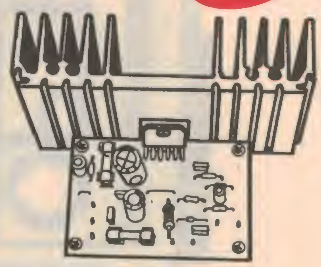
Cat K-3604 **$39.95**

PLEASE CONTACT YOUR NEAREST STORE FOR AVAILABILITY AS SOME KITS MAY STILL BE IN PRODUCTION.

Big Power, Small Price!

40W Amplifier Module

NEW



Looking for an easy-to-build audio power amplifier module with a bit more power? Then look no further - This single-chip power module will provide 40W RMS continuous into 8 ohms with extremely low distortion! It features the LM3876 power amplifier IC from National Semiconductor and is useful for a wide variety of audio applications. The kit comes complete with all components, heatsink, PC board, IC and fuses.

Typical Performance (using ±37.5VDC Power Supply):

Output Power:	40W Continuous into 8 ohms
Signal-To-Noise Ratio:	-106dB (20-20KHz)
Distortion:	0.002% @ 40W 1KHz
IHF Power Output:	60W @ 1KHz

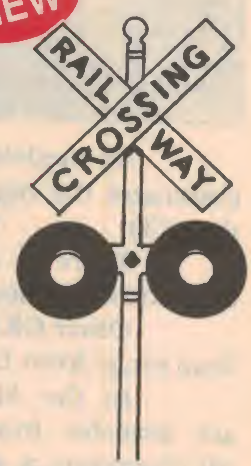
Cat K-5606 **$39.95**

SILICON CHIP March '94

Bring Your Model Railway To Life!

NEW

Level Crossing Light, Bell & Sensor Kits



Want the realism of a working level crossing on your model railway? But how do you get the lights and bells to trigger as the train approaches? Well, it's easy if you have these two kits - your miniature landscape will become just that little bit more realistic as soon as you install them! Suitable for both single and double-track intersections, the lights and bells are triggered by the sensor unit detecting a magnet hidden in the locomotive. Kits will be supplied in shortform with all components, PCB & necessary sensors.

Level Crossing Light And Bell Kit

Cat K-3028 **$24.95**

Level Crossing Train Detector Kit

Cat K-3026 **$39.95**

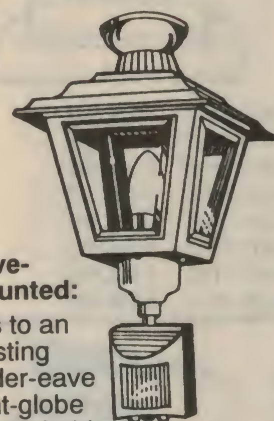
SILICON CHIP March'94

Bright Ideas To Beat Burglars!

Arlec Coach Lights that Switch On When They Detect Motion- A Great Way To Deter Intruders

These attractive exterior coach lights feature a built-in motion detector that switches the light on whenever someone moves nearby. Fit them to the walls or eaves of your home and banish dangerous dark areas forever!

Light-sensitive, they automatically switch off in daylight hours to save power and are available in two styles:



Eave-Mounted: Fits to an existing under-eave light-globe batten holder. Cat L-5342

Wall-mounted: With adjustable time delay and sensitivity. Cat L-5341*

* Must be installed by a licensed electrician.

New Low Price! $69.95

Was $79.95

ARLEC

*Available through all stores. On display at selected stores only.

DO IT YOURSELF AND SAVE!

If you have an existing batten-mount bayonet-style light fitting, the Eave-mounted model (Cat L-5342) can simply be plugged in as you would a light-globe!

An Exciting Hobby Starts Right Here!

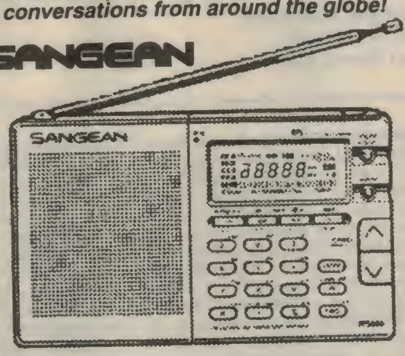
What Is Shortwave Radio, And Why Would I Want To Listen To It?

It's not just used by spies hiding from the secret police!

Shortwave lets you keep in touch with the world: Using one of Dick Smith Electronics' wide range of Shortwave receivers, you can listen in to a wide variety of music, news and current affairs programs unavailable on local radio, plus with more sofhisticated models eavesdrop on amateur, aircraft and commercial Shortwave conversations from around the globe!

A Top Performing Shortwave Receiver

SANGEAN



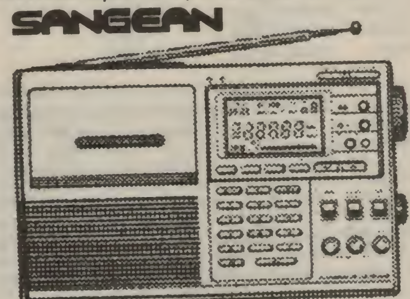
The easy way to listen in to shortwave, AM or FM! Offers simple keypad frequency entry, push-button selection of the 45 station memories, a scanning facility and, its back-lit LCD screen keeps you informed of all functions currently selected. Complete with dual-alarm, sleep and dual-time facilities plus earphones for FM stereo.

SAVE $40 Cat D-2847 **$229**

All-Band World Receiver With Cassette Player

Enter the fascinating world of shortwave radio with this sensational digital-tuned Sangean ATS-818CS. It provides continuous 1.62 to 30MHz Shortwave coverage, plus local AM/FM and longwave bands. The inbuilt cassette lets you record the station you're listening to or play your favourite tape. This professional-quality receiver is incredibly easy to operate, with 45 station memories, pushbutton scanning, direct keypad station entry or two-speed rotary tuning. It has a large back-lit digital display showing exactly what's happening, while an adjustable RF gain control ensures optimum reception, even under differing reception conditions! Plus, its dual-time clock with sleep function lets you wake to music or alarm.

SANGEAN



SAVE $50 Cat D-2842 **$349**

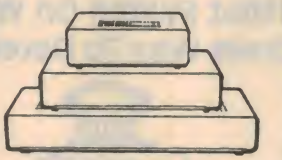
Specials valid till 31/3/94.

Get It All Together!

Whether it's quality cases and enclosures at very affordable prices or soldering equipment to suit both professionals and hobbyists alike, see Dick Smith Electronics first!

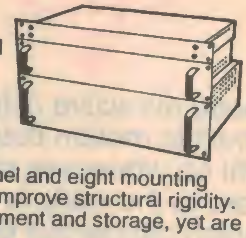
Steel Enclosures:

Easy-to-assemble and conforming with the IEC297 standard, these high-quality cases are sturdy and attractive, too! They pack flat for easy storage and shipping and feature easy-to-modify aluminium front and rear panels.



Length	Height	Depth		
203.2	x 63.5	x 177.8mm	Cat H-3100	**$19.95**
304.8	x 63.5	x 177.8mm	Cat H-3102	**$24.95**
431.8	x 63.5	x 177.8mm	Cat H-3104	**$29.95**
203.2	x 88.9	x 177.8mm	Cat H-3106	**$34.95**
304.8	x 88.9	x 279.4mm	Cat H-3108	**$44.95**
431.8	x 88.9	x 279.4mm	Cat H-3110	**$59.95**
203.2	x 132	x 279.4mm	Cat H-3112	**$44.95**
304.8	x 132	x 279.4mm	Cat H-3114	**$59.95**

19" Rack Cases



Heavy-duty steel rack cases designed and built to industrial standards, yet priced to suit the enthusiast. Superbly finished, this series complies with IEC 297, IEA RS-310 C1977 & DIN41494 standards and are compatible with all 19" equipment. Each is supplied with a spare "unflanged" front panel and eight mounting rails - ideal for heavy transformers and to improve structural rigidity. They come packed flat for convenient shipment and storage, yet are very easy to assemble.

	Length	Height	Depth		
1U 19"	424 x	38 x	254mm	Cat H-2682	**$75**
2U 19"	424 x	81 x	254mm	Cat H-2684	**$90**
3U 19"	424 x	127 x	332mm	Cat H-2686	**$105**

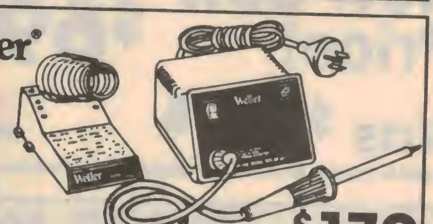
Outstanding value!

The DSE Solder Station

The DSE Auto Temp Soldering Station offers you the best value with features and quality to boot! With fully variable temperature control (from around 200-500°C) and a temperature meter. And it's fully approved by the Energy Authority! The station comes complete with lightweight iron holder, cleaning sponge, a comprehensive instruction manual and full servicing information.

Cat T-2000 **$159**

WTCPS Weller® Solder Station



Here's real value! Weller irons are the first choice of hobbyists, technicians and service people because of their quality and reliability.

Cat T-3000 **$179**

This superb soldering station has a non-burning silicon rubber power lead and a long-life, iron-plated tip. With 48 watts capacity, low (24V) output voltage, lightweight soldering pencil and special "closed-loop" temperature control.

Accessories to suit the DSE Solder Station:

Tips as listed are available from selected stores only.

Description		Cat No.	Price
Adaptor To Suit SMT (Surface-Mount Technology) Tips		T-2042	**$7.95**
Desoldering Tips			
20 x 20mm	Box Type	T-2025	**$29.95**
17 x 17mm	Box Type	T-2026	**$29.95**
16.3 x 16.3mm	Box Type	T-2027	**$29.95**
15.5 x 15.5mm	Box Type	T-2028	**$29.95**
12.5 x 12.5mm	Box Type	T-2029	**$29.95**
23 x 17mm	Tunnel Type	T-2030	**$29.95**
7 x 12.5mm	Tunnel Type	T-2031	**$24.95**
6 x 10mm	Tunnel Type	T-2032	**$24.95**
6 x 5mm	Tunnel Type	T-2033	**$24.95**

Description	Cat No.	Price
IC & IC Socket Removers		
8 Pin	T-2034	**$24.95**
16 Pin	T-2035	**$24.95**
18 Pin	T-2036	**$24.95**
24 Pin	T-2037	**$24.95**
Soldering Blade Tips		
10mm Large	T-2038	**$9.95**
5mm Small	T-2039	**$9.95**
Chip Parts Removers		
2.1 x 1.5mm Small	T-2040	**$9.95**
3.2 x 1.6mm Large	T-2041	**$9.95**

MAJOR DICK SMITH ELECTRONICS AUTHORISED STOCKISTS:
NSW ARMIDALE: New England Electronics 711 655 **BALLINA:** Ballina Electronics 867 022 **BATEMAN'S BAY:** Baycity Sight & Sound 725 030 **BATHURST:** Electronic Frontiers 323 933 **BOURKE:** Countrywide Services 722 150 **BOWRAL:** Bowral Electrical Suppliers 611 861 **BROKEN HILL:** Hobbies & Electronics 884 098 **COOTAMUNDRA:** Cootamundra Music & Light 422 561 **DENILIQUIN:** Deni Electronics 813 672 **DUBBO:** Chris's Hi Fi 828 711 **GOULBURN:** Tunlive 221 288 **GRAFTON:** Repairs & Spares 421 911 **GRIFFITH:** Miatronics 624 534 **GUNNEDAH:** Carter's Sportscene & Electronics 42 2230 **INVERELL:** Infolink Computer Systems 513 131 **KATOOMBA:** Niagara Photo & Sports 822 800 **KEMPSEY:** P & K Richards 631 134 **LEETON:** Leeton Audiotronic 532 800 **LIGHTNING RIDGE:** Lightning Ridge Solar Power 291 013 **LISMORE:** Decro Electronic Services 321 896 **LITHGOW:** Douroy Photographics 513 173 **MACKSVILLE:** Macksville Electronics 682 899 **MOREE:** Moree Electronics 522 091 **MUDGEE:** Headwear 723 895 **MURWILLUMBAH:** Strings & Things 723 684 **NARRABRI:** Namoi Computer Service 923 274 **NELSON BAY:** Nelson Bay Elect. & Hobbies 813 685 **NOWRA:** Nowra Electronics 210 722 **PARKES:** Strad Music Centre 623 366 **PORT MACQUARIE:** Port Electronics 836 875 **RICHMOND:** Silicon Crafts 784 101 **TAREE:** Manning Electronics 512 233 **TUNCURRY:** Tuncurry Electronics 545 006 **ULLADULLA:** Coastal Electronics 553 989 **WAGGA WAGGA:** Phillips Electronics 216 558 **WALGETT:** Walgett Electronic Centre 281 111 **WINDSOR:** Hawkesbury Electronics 776 722 **YASS:** Warmington Electrical 226 1411 **YOUNG:** Keith Donges 821 279 **VIC ARARAT**: Jerram Electronics 522 345 **BAIRNSDALE:** Green Gage Services 525 677 **BENALLA:** North East Electronics 622 710 **CASTLEMAINE:** Inspect Electrics 723 773 **COLAC:** Colac Electronics 312 847 **ECHUCA:** Gilmour Electronics 822 956 **HORSHAM:** Burgess Camera House 81 1680 LEONGATHA: Leongatha Photographics 623 227 **MILDURA:** Pullman Auto Pro 232 882 **MORWELL:** Roylaine Pty Ltd 339 458 **ROSEBUD:** Seatech Vic Pty Ltd 822 225 **SHEPPARTON:** Andrew Guyatt Electronics 219 497 **SWAN HILL:** Nyah District TV Service 329 303 **ST. ARNAUD:** Whartons Appliances 951 069 **WARRAGUL:** Roylaine 234 255 **WARRNAMBOOL:** Koroit St. Elect. Services 627 417 **WONTHAGGI:** South Gippsland Photo Service 721 411 **QLD AYR:** Delta Electrix 831 566 **BOWEN:** Plaza Electronics 863 477 **BUNDABERG:** Bob Elkin Electronics 521 785 **CALOUNDRA:** Electro-mart 918 533 **DALBY:** Hobby & Electronics 625 770 **GLADSTONE:** Electronic Enterprises 726 660 **GOONDIWINDI:** CTW Electronics 713 411 **INGHAM:** Masons Electronics 763 188 **INNISFAIL:** Innisfail Hi-Fi 612 014 **MACKAY:** Steven's Electronics 511 723 **MARYBOROUGH:** Keller Electronics 214 559 **MOSSMAN:** Mossman Electronics 982 200 **MT. ISA:** Outback Electronics 433 331 **PIALBA:** Keller Electronics 283 749 **STANTHORPE:** Granite Belt Communications 813 333 **TAS BURNIE:** Electronic City 314 760 **DEVONPORT:** Al Electronics 248 322 **SA MT. GAMBIER:** Hutchesson's Communication 250 400 **PORT LINCOLN:** Basshams TV & Comp. World 830 075 **WHYALLA:** Eyre Electronics 454 764 **WA ALBANY:** Micro Electronics 412 077 **BUNBURY:** Micro Electronics 216 222 **GERALDTON:** Angora Lighting 211 278 **MANDURAH:** Mandurah Hi FI 581 2206 **MARGARET RIVER:** CPA Electronics 573 888 **PORT HEDLAND:** Ivan Tomek Electronics - Retail 732 531

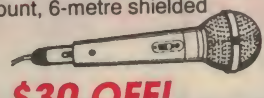
Sounds Great!

Clearout Specials

High-quality Uni-Directional Mic

Ideal for halls, auditoriums, broadcasting - wherever sound quality is of the essence. Comes with stand mount, 6-metre shielded cable and 6.5mm plug.

Specifications:
Input impedance: 600 ohm (balanced)
Frequency response: 50 - 15,000Hz
Sensitivity: -76dB @ 1000Hz

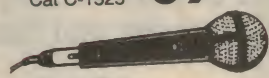


$30 OFF!
Cat C-1525 **$89.95**

Uni-Directional Dynamic Mic

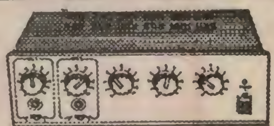
Superb performance and quality construction make this uni-directional dynamic microphone perfect for stage, vocal, studio or broadcasting. Has a built-in tone control and comes complete with stand mount, 6 metre shielded cable and 6.5mm plug.

Specifications:
Input impedance: 600 ohm (balanced)
Frequency response: 50 - 18,000Hz
Sensitivity: -74dB @ 1000Hz



$30 OFF!
Cat C-1530 **$99.95**

30 Watts RMS P.A. Amplifier



Ideal for schools, auditoriums or the workplace - anywhere a quality, reliable PA system is required. Can be used as a stand-alone unit or with external tuners, cassettes players and booster amplifiers. Features include: Two auxiliary inputs for tuners, standard cassette players and two microphone inputs. One of the microphone inputs has priority paging (it automatically fades out the other inputs).

Specifications:
Inputs -
Mic 1: Balanced 600 ohm/0.5V
Mic 2: Unbalanced 600ohm/0.5V
Aux.1 & 2 : 100k ohm/200mV

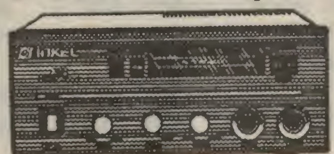
Outputs -
Speaker Outputs: 4, 8 & 16 ohms
Line Outputs: 70V (163 ohms) & 100V (330 ohm)
Auxiliary 1 & 2: 600 ohm/1V (0dB)/RCA sockets
Power Supply: 240V AC or 13.8V DC

* Not on show at all stores, limited stocks only.

$50 OFF! Cat A-8030 **$249**

12V Powered Mobile

Inkel P.A. Amplifier & Cassette Player

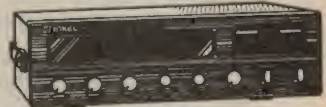


Perfect for mobile use, this 20-watt unit features two mic inputs and separate volume controls for each mic and for the cassette deck. Has rear connection for a booster amp and is188mm(W) x 75mm(H) x 165mm(D).

Cat A-8031 **$279**

* Not on show at all stores, limited stocks only.

Inkel 30W P.A. Amplifier



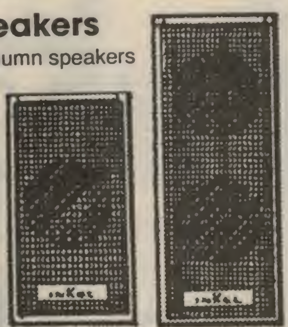
With 30W (R.M.S.) at less than 0.5% THD (Total Harmonic Distortion), three mixable inputs (2 x mic & 1 x Aux) plus a telephone interface and four-tone chime, this is an extremely useful amp for workplace and public announcement use.
Dimensions: 330mm(W) x 88mm(H) x 260mm (D) -it weighs 4.6kg.

Cat A-8032 **$325**

* Not on show at all stores, limited stocks only.

Inkel P.A. Column Speakers

Built tough for outdoor use, these column speakers feature matching transformers, aluminium cabinets and steel grilles. They come complete with mounting brackets.



10W P.A. Speaker Model CS-510
Cat A-8225 **$99.95ea**

20W P.A. Speaker
Model CS-520
Cat A-8226 **$139.95ea**

* Not on show at all stores, limited stocks only.

High Quality Bookshelf Speakers

A superb set of two-way hi-fi bookshelf speakers that are ideal for PA, surround sound systems in the home, professional studios or even the car or boat. They have a built-in 70/100V line transformer and will handle 35 watts RMS).
Features include: Selectable impedances, a 100mm woofer and 19mm tweeter. With a frequency response of 90Hz to 18,000Hz, they measure just 190 x 125 x 125mm. Supplied with wall brackets and cable.

Cat A-8200 **$159.95**

Bargain Extension Speakers

Complete with built-in 100-volt line transformer, they're ideal for wall mounting in assembly halls, etc. Its 8" twin-cone speaker has a 10-watt (RMS) handling capacity. Selectable impedances are 500, 1k, 2k, 4k & 8k ohms with 100 volt tappings of 10, 5, 2.5 & 1.25 watts.

Cat A-8210 **$79.95ea**

PHONE, FAX & MAILORDER SERVICE
Outside Sydney (FREE Call) 008 22 6610
Sydney and Enquiries - (02) 888 2105
Fax: (02) 805 1986 or write to
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PO Box 321 NORTH RYDE NSW 2113
All major Credit Cards accepted. O/Nite Courier Available.

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Low cost construction kit:

REACTION TIMER BASED ON A MICROCONTROLLER

Here's a modern high-tech version of the familiar 'first to press their button' game. Thanks to the use of a low cost pre-programmed microcontroller chip, it's not only very easy to build but also displays the actual reaction times in milliseconds, of the 'winner' and 'loser'.

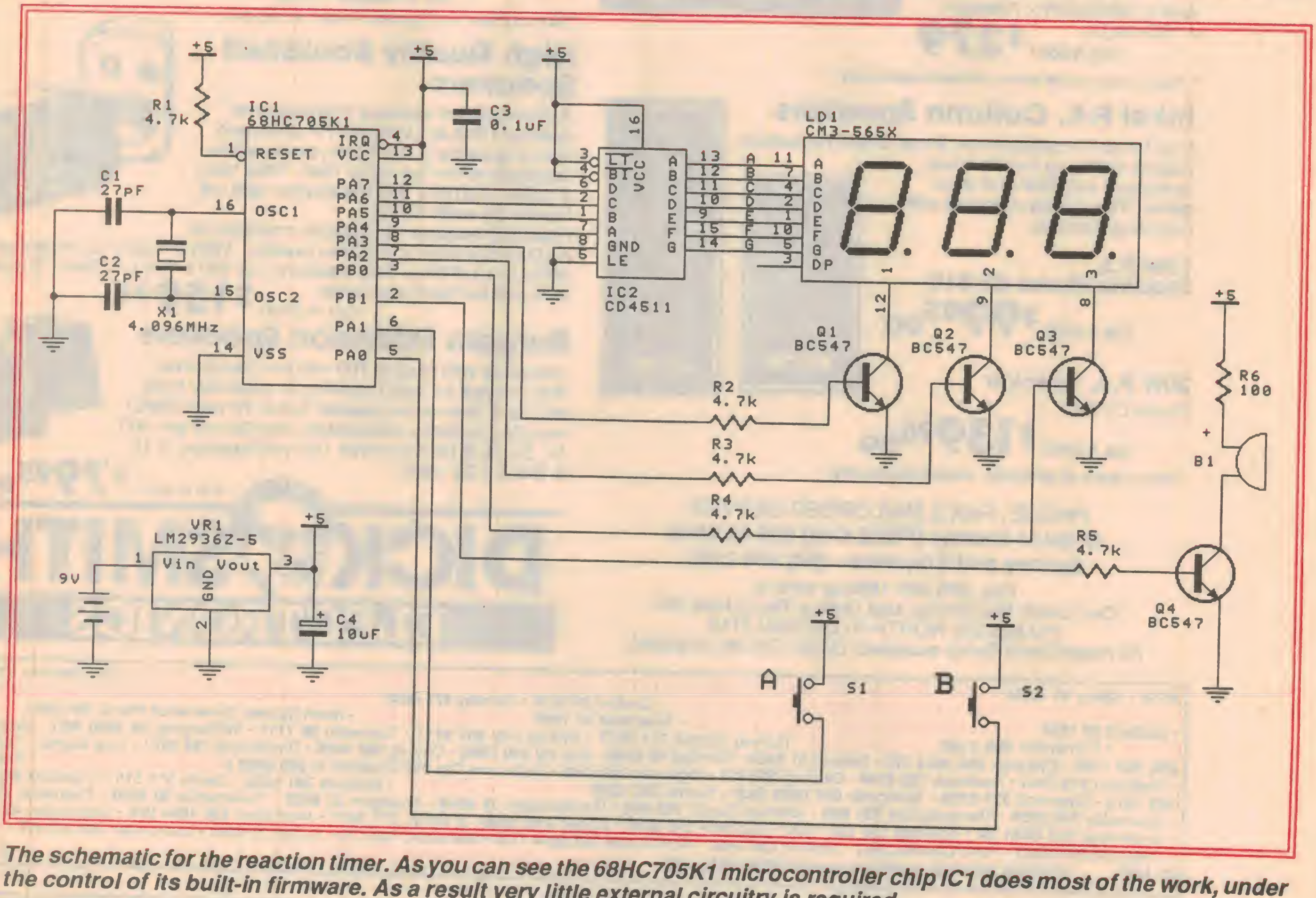
by PETER CROWCROFT

A quiet revolution is taking place in electronics today, one that is almost as important as the replacement of valves by transistors and ICs in the 1960's and 70's. This is the rise of the microcontroller. (For convenience we will often abbreviate microcontroller to 'uC' in the text which follows.) The increasing power and versatility of these devices, coupled with steadily decreasing prices, is now such that many of the simplest logic circuits may now be better designed using them.

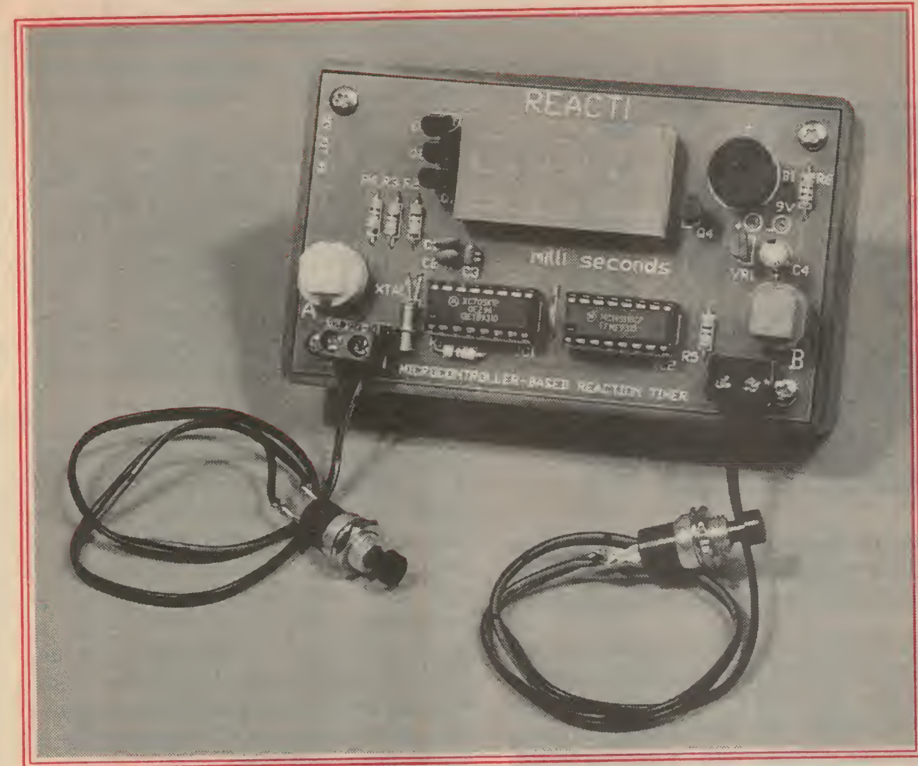
Microcontrollers are basically a complete computer on a single chip — a central processing unit plus ROM and RAM memory, a clock, input/output ports and often inbuilt peripheral devices (such as a timer, AD/DA and communication ports).

Today they are to be found all around us. To name a few applications, they're now found in washing machines, microwave ovens, mobile phones, bar code readers, printers, video cassette players, photocopiers and, most importantly, motor cars — for engine fuel management, braking systems, active suspension, multiplexed wiring, mirror and window movement.

In all of these cases the application program inside the ROM of the uC is not accessible to the hobbyist and therefore of



The schematic for the reaction timer. As you can see the 68HC705K1 microcontroller chip IC1 does most of the work, under the control of its built-in firmware. As a result very little external circuitry is required.



little use. Even if it was, the tools to develop programs for these devices are expensive — typically over US$1000.

It has generally also been true that to learn to program uC's has required attendance at a technical college or some similar formal teaching institution. To try to teach yourself programming of the older uC's, such as the 8748 or 8051 family, from a data book was not easy.

Times have changed

This situation has changed in the last year or two. Low cost uC's and the tools to develop and program code for them have now reached the level where the amateur can become involved.

In this respect two chips have led the way. They are the PIC series from Microchip and the K series chips from Motorola. The PIC chips have been out longer, but the development tools to use them are relatively expensive (though coming down) and the instruction set is a bit strange.

We will not discuss them further here. (Small uC's from other manufacturers also suffer from the problem of high cost of tools for code development and programming, even higher than the PIC uC's.)

The beauty of using the K1 Motorola range of uC's is that the full range of development tools needed by the amateur to develop applications are readily available at low cost, say under US$200. The programs (called assemblers) to develop code for the uC on a PC are freeware, and are available from Motorola and its distributors. The hardware schematic for the programmer is published in the Motorola Data Book, and the software to use the programmer is also freeware. A low-cost in-circuit simulator, which also acts as as programmer, is available also with software, from Motorola dealers.

The K series uC chips come in various packages, including the EPROM version. A truly excellent manual which introduces the K series from basic principles, called *Understanding Small Microcontrollers* is also available from Motorola.

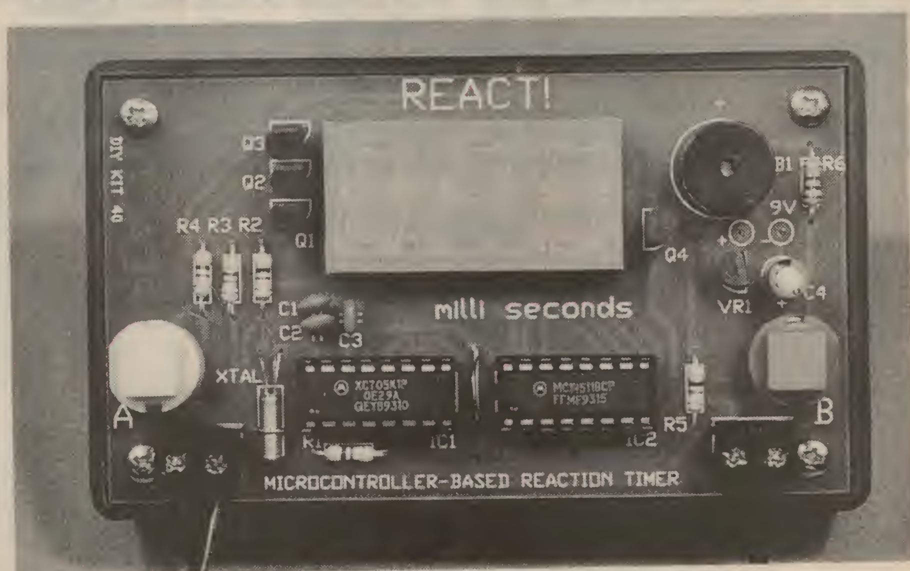
This project & kit

This reaction timer project is designed to provide a low cost application of the 68HC705K1 uC, to demonstrate how easy it is to use this kind of chip for simple real-world tasks. Using a microcontroller in a reaction timer is cheaper, uses fewer components and allows a flexibility not possible with straight logic components.

The reaction timer has been designed in Australia for my company DIY Electronics, which packages kits in Hong Kong for export to countries such as Australia. As a result a complete kit for the project may be ordered from Alpine Technologies in Victoria, at the address shown in the parts list. The reaction timer kit costs $45.90 and may be paid for by cheque, money order, Mastercard or Bankcard. The kit will be posted to you directly from Hong Kong, and any import or other duties which may apply must be payable by the buyer (if required); they are not included in the purchase price.

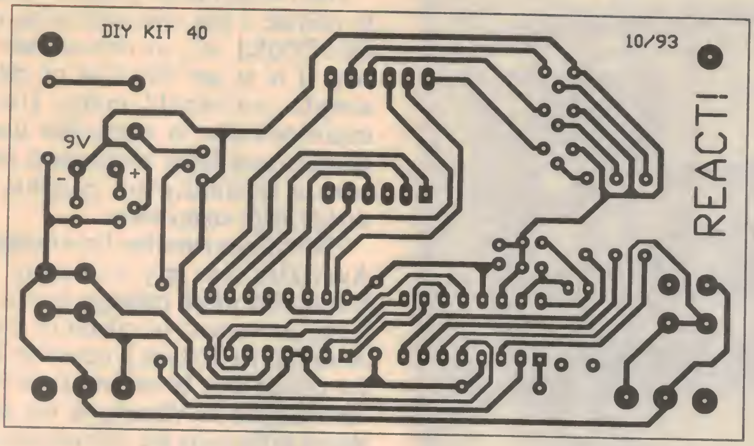
Either one or two players may use the timer. Their reaction time to press a button, after a 'beep' sounds, is accurately measured to the nearest thousanth of a second and displayed on the LED display. If two players play, then both reaction times are displayed in turn. The beep occurs after a random delay of anything between zero and four seconds. The system uses a 4.096MHz crystal for accurate time measurement.

All the software code to operate the timer is squeezed into just 1EA hex (490 in decimal) bytes of ROM, which is almost all the ROM space available inside the K1 (1F0 hex or 496 decimal). The complete source code is provided



A close up of the top of the reaction timer, showing where everything goes — apart from the battery, which mounts inside the box underneath.

Reaction Timer



Here is the PCB pattern for the reaction timer, for those determined to etch their own. Although the pattern is not copyright, we imagine that most builders will want to use a DIY Electronics kit — which includes the preprogrammed micro.

on a floppy disk provided with the kit, fully commented so that you can use it to teach yourself 68HC705K1 programming. This is actually the second kit in a planned series designed to show how microcontrollers are used and programmed. The first kit is a down counter (see box).

The reaction timer kit is constructed on a single-sided printed circuit board, which fits into a small plastic jiffy box. Protel Autotrax and Schematic CAD packages were used to design it. The firmware for the 68HC705K1 was developed using a Motorola ICS (in-circuit simulator), purchased from Motorola.

Circuit description

The heart of the circuit is the 68HC705K1 uC (IC1) and the firmware it contains. The other items are the power supply, oscillator components and I/O components used to get information into and out of the uC.

The K1 is a low-end version of the Motorola 68HC05 eight-bit uC series. Its 16-pin DIP package is the smallest for any eight-bit uC, with the lowest number of pins. Here we use a one-time programmable or 'OTP' version of the 68HC705K1. We have already put the firmware program into its internal ROM, and since there is no quartz window in it, the program cannot be erased.

The K1 chip has its own on-chip clock oscillator, and here we have used a 4.096MHz crystal (X1) with capacitors C1 and C2, to make it run at an accurately defined frequency. Successive division by two in the 15-bit multi-function timer inside the K1 generates a TOF (timer overflow) interrupt every 500 microseconds. Every second interrupt is used to increment a 1ms counter inside the chip, and this becomes the actual reaction timer.

IC2 is a BCD to seven-segment decoder/driver, which is used to take BCD data from I/O lines PA4-7 of the K1 (configured as outputs), and drive the segment anode lines of the multiplexed three-digit LED display LD1. The individual digit cathodes of the display are controlled using transistors Q1-3, driven from the PA3, PA2 and PB0 lines of the K1. In this way the display multiplexing is done using a minimum amount of hardware, with the firmware doing most of the work.

Another K1 I/O line, PB1, is also configured as an output line and used to drive transistor Q4, which in turn controls the piezo beeper B1. The remaining I/O lines PA0 and PA1 are configured as input lines, and used to connect to the two pushbuttons A and B. No pull-down resistors are required on the inputs, as the K1 provides programmable pull-down resistors on chip.

When +5V is applied to either of these inputs by pressing either pushbutton, the K1 'awakens' from its low-power STOP mode. (It enters this mode if there has been no activity on the input lines for more than one minute.) The regulated +5V power rail needed by the K1 and its surrounding circuitry is derived from a small 216-type 9V battery using an LM2936 three-terminal regulator from National Semiconductor. This is an ultra-low quiescent current 5V regulator, in a TO-92 plastic package.

There is no hardware off/on switch, as the current drain from the battery when the K1 uC is in STOP mode is so low. We measured 25uA battery drain when the K1 was in STOP mode, and 10mA when it was running.

Firmware description

The uC sits in a powered-down state (STOP mode), drawing only a few microamps until either key is pressed. The timer is based around the multi-function timer in the K1. The Real Time Interrupt (RTI) generates an interrupt every 16ms (milliseconds), and this is used to:

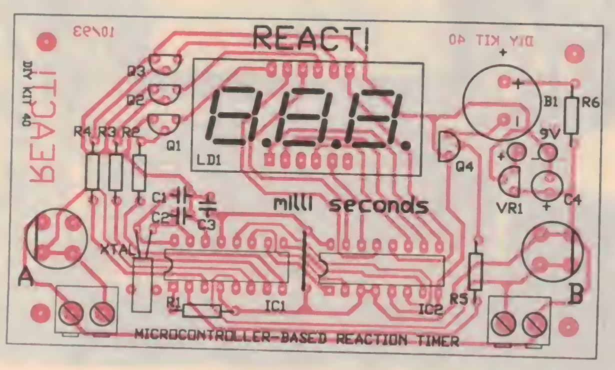
- Count the time since the last key was pressed, so that the unit will re-enter STOP mode after one minute of inactivity;
- Scan the display and show the results.

The TOF interrupt generates an interrupt every 0.5ms, as noted earlier. This is used to:

- Do 'beeps';
- Count the reaction time;
- Check for key presses.

To see how the firmware works, print out the **REACT.LST** program contained on the floppy disk which comes with the kit. This is a combined listing of the program code, the mnemonics (assembler language) used to write it, line numbers for reference — and, most importantly, a lot of comments to explain what is happening.

Along with the listing file, the disk also provides the assembler source file **REACT.ASM** and a header file **K1DEF.ASM**. The purpose of the latter



And finally, here's the overlay diagram. Use this together with the close-up photo, as a guide when you're wiring up the project.

is to provide the assembler with definitions of the mnemonics used in the source file itself.

It is difficult to remember binary bit patterns and hexadecimal addresses when you write code. It is far easier to remember mnemonic names for register addresses and bit positions. Using these names also makes the program easier to read. **K1DEF.ASM** consists entirely of EQUate directives, defining these mnemonics as labels for a binary number or address. Note that this is a general purpose header file. Not all labels defined in the header file are used in *REACT.ASM*. You are free to use *K1DEF.ASM* when you write your own K1 programs, so print it out and examine it. **K1DEF.ASM** is called by **REACT.ASM** using the *$include* directive, when timeout is assembled.

As well as providing the full firmware files on floppy disk, the kit also provides printed flowcharts to make its operation clearer. There are a number of flowcharts, as the firmware may be divided into several functional sections. The K1 memory map is also provided.

(Note that none of the program listings or flowcharts are provided in this article, as they would take up far too much space. However if individual readers send a formatted (MS-DOS) 1.2MB or 1.4MB floppy disk to the *EA* Reader Information Service, with the usual fee of $7.50 to cover handling and postage, we can provide a copy of all files.)

Assembling the kit

Check the components against the parts list (also provided as a file on the floppy disk). Place them according to the overlay diagram. Make sure to get the buzzer, 'hatkey' pushbutton switches and capacitors around the correct way. The LED display unit must have the decimal points on the bottom. There is no off/on switch.

There is a single wire link to be fitted to the board, between the two ICs. The ICs also fit in sockets, and needn't be fitted until the rest of the circuit is completed. Tie-down pads have been provided for a loop-link to secure the crystal to the PCB. The crystal can be inserted either way around.

Note that you have a choice of using either the 'hatkey' switches which mount directly on the PCB, or the off-board switches which connect to the two small terminal blocks.

The battery stays inside the box, so solder the wires of the battery snap to the copper side of the board. Stick the battery down inside the box with some adhesive or double-sided tape. It will last for many months of use, because of the ultra-low current voltage regulator used in the circuit. (Our prototypes are still working very well on their original batteries, despite hours of testing.)

Using it

Pressing a switch turns the unit on. (There is no separate off/on switch, remember; the activity level is all done in firmware.) The display normally shows the fastest reaction time in milliseconds (thousandths of a second), achieved so far by any player. This time is accurate to over two decimal places. However the very first time the timer is used after the battery is connected to it, there is no fastest time to display, so a '999' is displayed...

Press either key to trigger the unit. The display will change to 000. After a random period of time between zero and four seconds, the unit will beep and the display will clear. Now press either button as quickly as you can. The display then shows '1' (to indicate the winner), in the display digit closest to the key that was pressed first. Then it will show the winner's reaction time in milliseconds.

The display will then show the time taken in milliseconds for the second key to be pressed — if it was pressed. The display will cycle through the times and first/second indicators until a key is pressed to return to the start. Only reaction times to 999ms are recorded. If you cannot react to a beep in that time, then perhaps you better give up electronics and try lawn bowls...

If a key is pressed *before* the beep, then no time is displayed for that key. The other key, if pressed legally will display the reaction time as usual. If no keys are pressed within a second, '999' will be displayed.

Should both keys be pushed at the same time, only the one time will be displayed. If no keys are pressed for one minute the unit will switch itself off automatically. Terminal blocks, twin cable wire and push-on switches are included with the kit, so you can use the timer at a comfortable distance away from it.

Final comments

If your reaction timer doesn't work, poor soldering is the most likely reason — so check all of your solder joints carefully under a good light. Next check that all components are in their correct position on the PCB, especially the two ICs, the transistors and capacitors.

If the display turns on *very* brightly, remove the battery because the oscillator circuit is not working — and there are no current limiting resistors to protect the display (the brightness is all controlled by the firmware). Make sure you did not mix up the voltage regulator with one of the transistors — they both come in similar TO-92 packages.

Also make sure you added the link to the PCB, and check that the flats on the katkey switches are facing outwards, as indicated on the overlay...

Finally, for suggestions on learning 68705 assembler code, see the **READ.ME** file on the floppy disk. ❖

'TIMEOUT': another DIY kit

In addition to the reaction timer kit described in this article, Dr Crowcroft's company DIY Electronics has developed another small kit to provide further 'hands on' experience with programming and use of the Motorola 68HC705K1 microcontroller.

Dubbed 'Timeout' and carrying the number K38, the kit is for a simple down-counter which counts for either 60 or 90 seconds, beeping every 10 seconds — until the final 10 seconds, when it beeps every second.

This kit is also based on the 'K1 microcontroller, and has a very similar physical arrangement as the reaction timer except that there are only two single-digit LED displays. As with the reaction timer, all firmware source code is provided on floppy disk as well as flowcharts, schematic, PCB pattern, etc in the documentation. The K38 kit is available for $39.50, in the same way as the reaction timer kit.

PARTS LIST

Resistors

1/4W carbon, 5%:
1 100 ohms (R6)
5 4.7k (R1-5)

Capacitors

2 27pF ceramic (C1, C2)
1 0.1uF monolithic (C3)
1 10uF electrolytic (C4)

Semiconductors

1 68HC705K1 OTP microcontroller (IC1)
1 CD14511 BCD/7-seg decoder-driver (IC2)
1 LM2936-5 voltage regulator (VR1)
4 BC547 NPN transistors (Q1-4)
1 CM3-5655 three-digit LED display

Miscellaneous

1 PC board, 96 x 55mm, coded K40
1 Plastic case, 100 x 60 x 30mm, with screws
2 Push-on 'hatkey' switches
2 Two-way terminal blocks, PCB mounting
1 Piezo buzzer, 5V (B1)
1 4.096MHz quartz crystal
9V battery snap lead; two small push-on switches; six- foot length of twin-lead cable; two 16-pin DIL sockets for ICs; documentation and floppy disk.

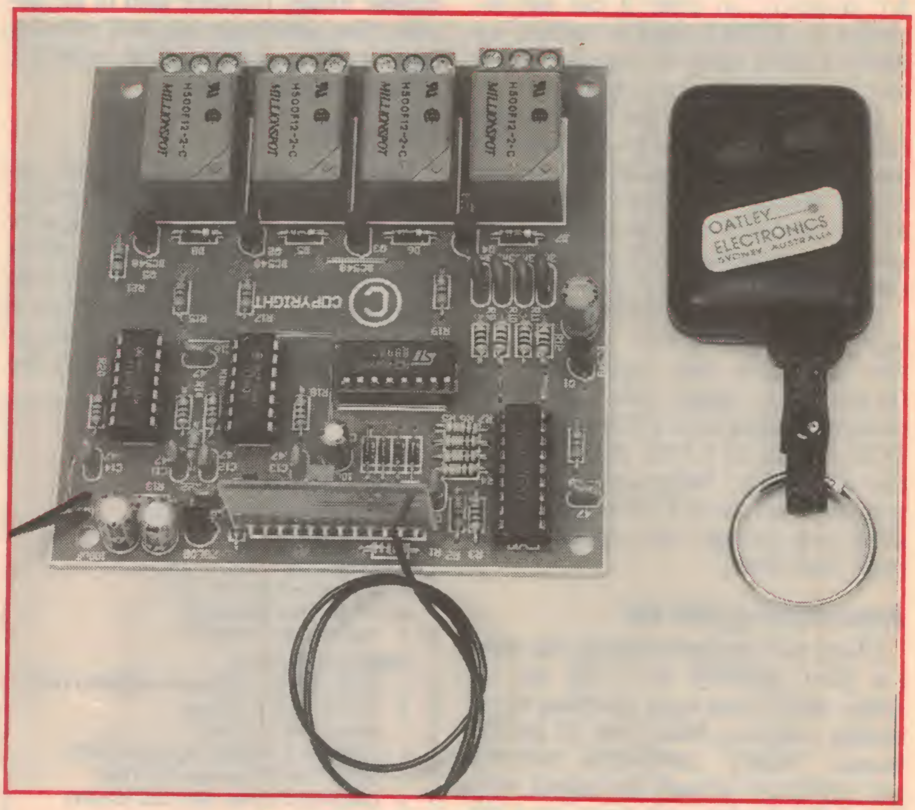
Note that all of the above parts are available in a kit priced at $45.90. Orders should be sent to Alpine Technologies, PO Box 934, Mt. Waverley 3149. Kits will be despatched from Hong Kong via airmail.

Construction Project:

FOUR CHANNEL REMOTE CONTROL

Featuring a transmitter small enough to keep on a key ring, this UHF remote control system also has a pre-built receiver module. This module in turn solders to the relay board, which has four relays operated by the decoding electronics — giving a compact, inexpensive remote control system.

by PETER PHILLIPS



Over the years, Oatley Electronics has become almost synonymous with UHF remote control systems. This latest design, also from Oatley Electronics, fits somewhere between their single channel system described in the January and April 1989 editions and the 12-channel version presented in March 1993.

It seems many readers are interested in UHF remote control systems, and this latest four channel version is in response to popular demand. Although the decoding allows four separate relays to be operated, the transmitter is actually limited to three channels. As you can see from the lead photo, the transmitter has two buttons, where the third channel is accessed by pushing both buttons together.

However, some people will want two transmitters (or more) and a relatively simple modification to the second transmitter makes the fourth channel available. This feature could be useful in a number of cases. For instance, both transmitters might use channel 1 to operate a garage door opener. However, channel 2 on one transmitter might control the burglar alarm in your car, while channel 2 (now channel 4) on the modified transmitter controls the burglar alarm in another car.

The receiver module comes already built, and uses surface mount construction. It solders directly to the decoder/relay driver board, and requires no adjustments. The relays are toggled with each press of a transmitter button, and the relays have a massive 12V, 12A contact rating.

Like the previous systems, the transmitter has a trinary encoder IC and the receiver has a corresponding decoder. These devices have eight address pins, which must be set so both ICs have the same address. If you have another UHF remote control system, interaction can be prevented by selecting a different address in each system. This is explained in more detail later.

The system therefore needs two parts: the transmitter and the receiver/decoder/relay PCB. The kit for the project includes professional quality screen-printed PCBs, to make construction very straightforward.

The transmitter has a range of 100 metres or more and a LED lights when a button is pressed, to give an indication of the state of the battery. Current consumption for the receiver/relay PCB depends on how many relays are energised, where each relay coil takes about 30mA. So if all relays are on, the total current consumption is around 120mA, low enough for battery operation.

We'll describe both sections individually, starting with the transmitter...

The transmitter

The circuit of the transmitter is shown in Fig.1 and is based around an AX526 trinary encoder IC. This IC has four data inputs, with two (D3 and D2) connected to the pushbuttons. The eight address lines are connected to either a logic 1 (Vcc), logic 0 (ground) or left open-circuit. The corresponding decoder in the

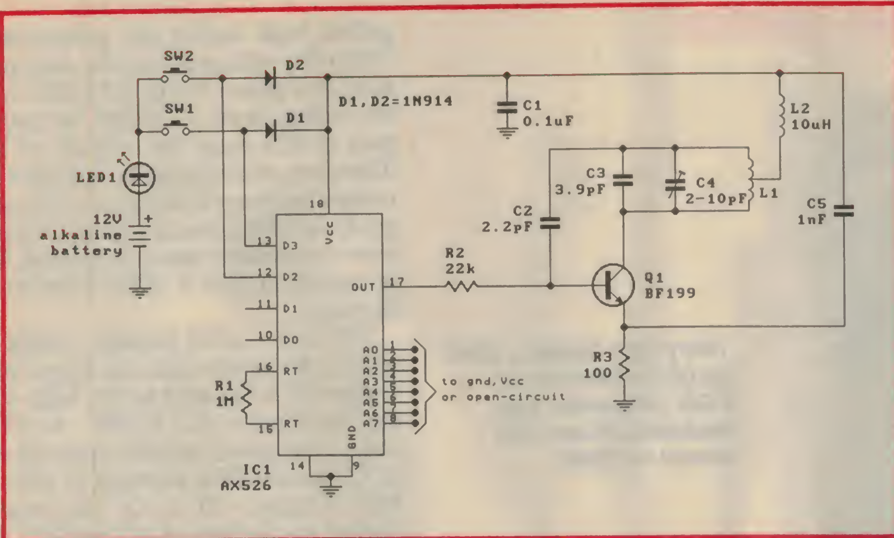


Fig.1: The transmitter is based around a trinary encoder that produces a digital output depending on which button is pressed. This circuit switches the 304MHz oscillator around Q1. Power is supplied to the circuit via D1 or D2 when either pushbutton is pressed.

receiver must have its address lines set the same as the encoder. The internal clock frequency of the IC is determined by the value of timing resistor R1 and the corresponding timing resistor for the decoder in the receiver section should have a similar value.

When either pushbutton is pressed, the data line connected to the pushbutton is set to a logic 1 and power to the rest of the circuit is supplied through one of the two diodes. Pressing *both* buttons causes a logic 1 at both the data inputs.

The code sequence determined by the state of the data inputs then appears at pin 17, along with other data such as the address of the IC. This signal controls the transmitter oscillator, where a logic 1 produces a pulse modulated at 304MHz, and a logic 0 produces nothing. The transmission is therefore a series of pulses on a 304MHz carrier.

The oscillator section is around Q1, and its operating frequency is adjusted to 304MHz with trimmer C4. The antenna is etched on the PCB and forms part of the tuned circuit.

When a button is pressed, the supply current to the transmitter flows via the LED. Therefore you can tell the state of the battery with the LED, which pulses during a transmission.

The receiver/decoder

The circuit for this section is shown in Fig.2. The pre-built receiver module is entirely stocked with surface mount components and comes complete and already aligned to 304MHz. This module contains a bandpass filter, an RF preamplifier, a regenerative detector, an amplifier and a Schmitt trigger output. A short length of wire (250mm or so) as an antenna is connected to pin 2 and the output is from pin 5. The test point at pin 9 shows the detected output signal, at around 4Vp-p.

The output of the module is the original digital data sent by the transmitter, and is applied in serial form to the input of trinary decoder IC1, type AX527. The address inputs of this IC should match

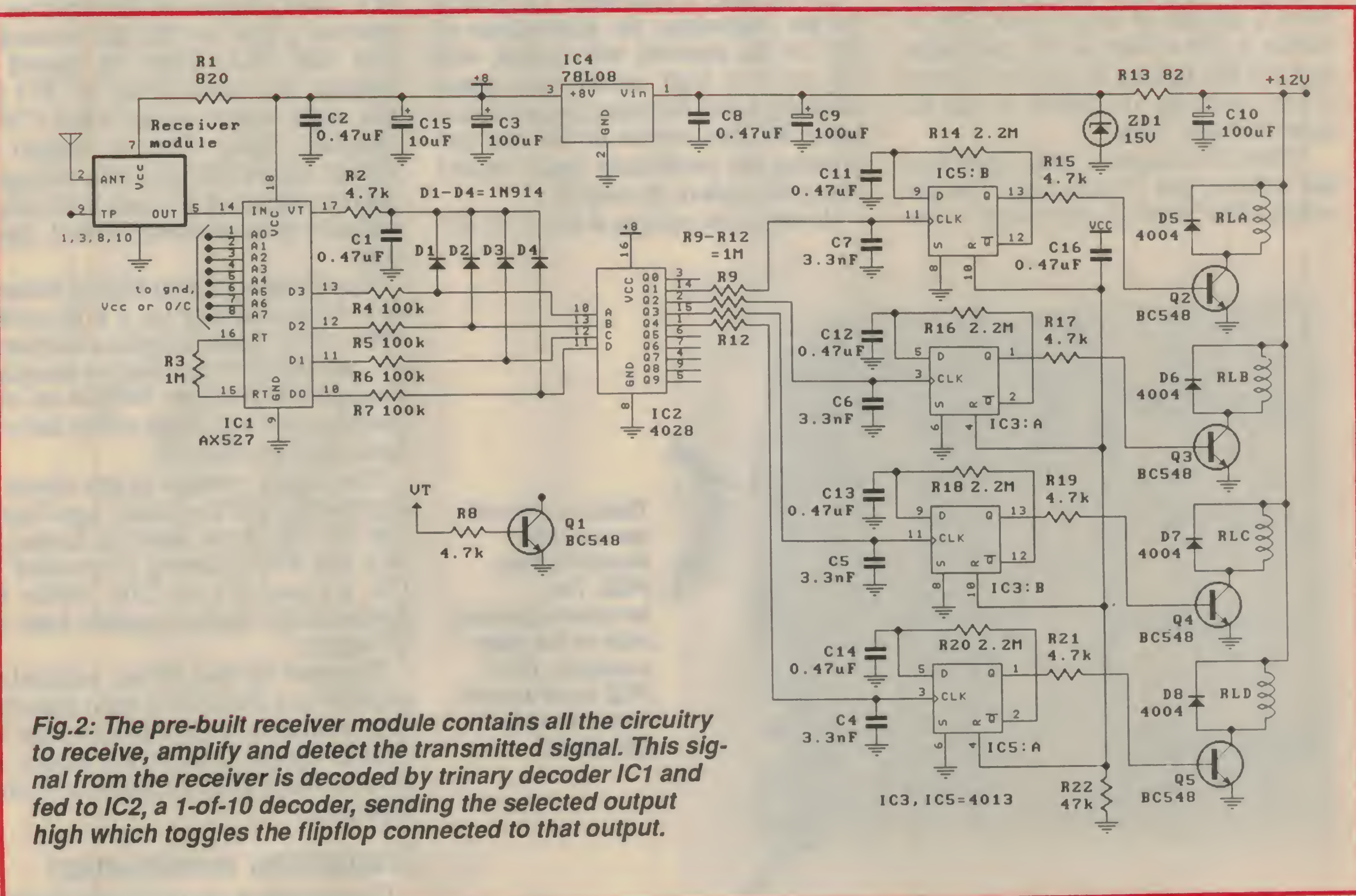
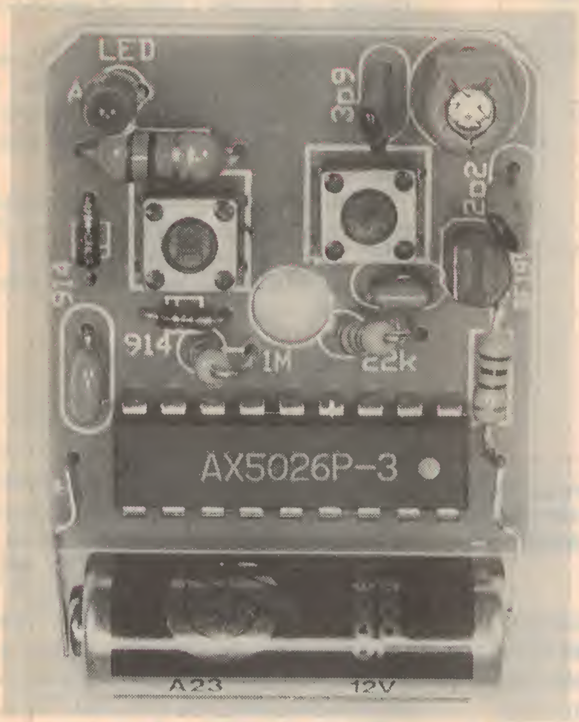


Fig.2: The pre-built receiver module contains all the circuitry to receive, amplify and detect the transmitted signal. This signal from the receiver is decoded by trinary decoder IC1 and fed to IC2, a 1-of-10 decoder, sending the selected output high which toggles the flipflop connected to that output.

Four channel remote control



This photo shows a close-up of the transmitter PCB. Notice that two resistors (R1 and R2) mount vertically.

those of the encoder in the transmitter, and the value of R3 (timing resistor) should also be equal to its equivalent in the transmitter.

In practice, these two resistors can have a spread of two to one. For instance a 1M resistor in the transmitter and a 1.8M resistor in the receiver will work, although it's better to use the same nominal value.

When IC1 receives a valid signal from the receiver, pin 17 goes high. The data outputs also respond, going high or low depending on the input at pin 14. However, because the data outputs are latches, the diode logic around D1 to D4 is needed to gate the data to IC2.

For instance, if pushbutton 1 is pressed on the transmitter, the data outputs of IC1 (in the receiver) will respond, with D3 set to a high and all other outputs cleared to a low. Releasing the pushbutton leaves the data outputs in this state and pressing the pushbutton again doesn't change the state of the outputs.

However, the voltage at pin 17 of IC1 pulses high during the transmission. When this voltage is low, the data inputs to IC2 are pulled low by D1 to D4. When the voltage at pin 17 is high, the data inputs to IC2 equal the outputs of IC1. Therefore, even if the data outputs of IC1 remain unchanged, the data to IC2 changes from 0000 to the data from IC1 whenever a transmitter button is pressed. This is needed to give a clock pulse to the flipflops.

IC2 is a 1-of-10 decoder, where the code at the inputs sends one output high. Output Q0 is not used as it is high when the data input to IC2 is 0000. As we've already explained, the only time the data to IC2 is not 0000 is when pin 17 of IC1 is high. Outputs Q1 to Q4 are used to operate the flipflops of IC3 and IC5. The PCB pattern has pads allowing connection to the remaining outputs of IC2 if you want to expand the system.

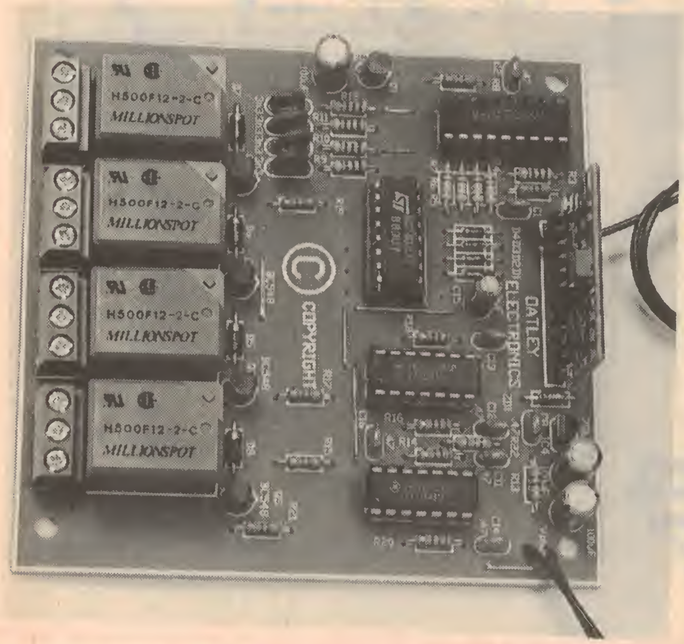
The flipflops are connected to change state (toggle) each time a positive going pulse appears at the clock input. This is achieved by the connection from the Q-bar output to the D input via an RC network. The time constant of this network prevents false toggling due to noisy signals. The capacitor at the clock inputs of each flipflop also prevents false toggling due to noise.

When power is first applied to the PCB, the Q outputs of the flipflops are reset to a low by the RC network of C16 and R22. Reset is caused by sending the reset inputs of IC3 and IC5 high, which occurs when C16 is charging. Once C16 is charged the voltage across R22 (also the voltage at the reset inputs of IC3 and IC5) falls to virtually zero, allowing normal operation.

The Q output of each flipflop connects to a driver transistor via a 4.7k resistor. When the Q output is high the transistoris on, and therefore the relay is energised. Protection diodes type 1N4004 are connected across each relay coil to limit the back-EMF at switch off.

The supply voltage to the circuit is regulated by an 8V regulator, type 78L08. The 12V DC input source is limited by R13 and ZD1. Filtering is provided by C2, C3 and C8 to C10, while R1 decouples the receiver module from the 8V supply.

Transistor Q1 and R8 are included on the PCB as a driver for a valid transmission indicator. This transistor can be used to operate a LED or a buzzer, to give feedback when a transmitter button is pressed.



This is a view of the receiver/decoder/relay PCB. The terminals connect only to the relay contacts. The PCB track layout is not rated to take 240V.

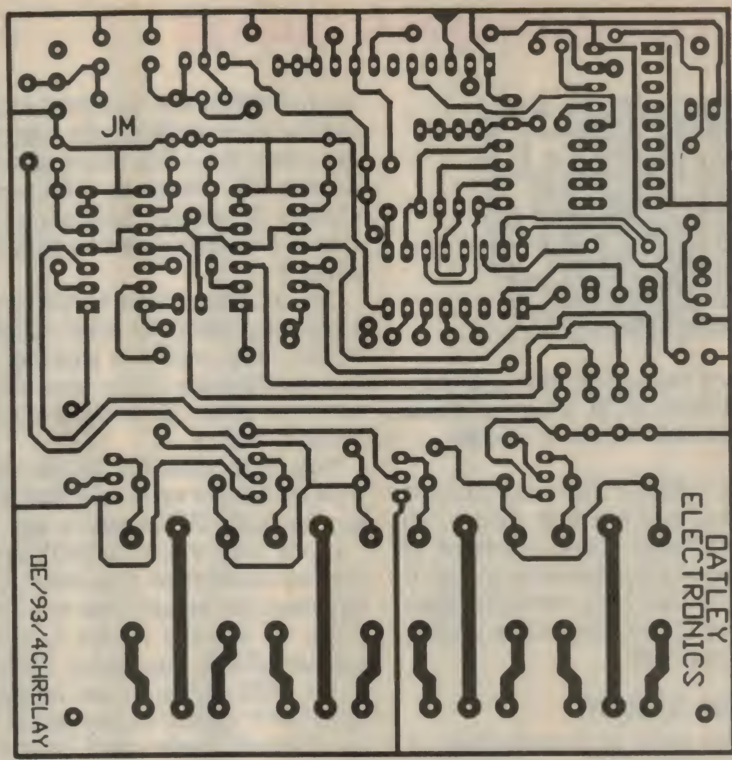
Transmitter construction

Construction of the transmitter is simp-

ly a matter of loading the PCB as per the screen printing on the PCB itself, or as shown in the layout diagram of Fig.3. Because of its compact size, all components need to be mounted as close as possible to the PCB. The transistor can be mounted 2mm or so clear of the PCB. The LED should clear the PCB by about 3mm so it can poke through the hole in the top of the case. The cathode side of the LED faces in, and is identified with a flat on the flange.

The switches can only go two ways, and either way will work. The IC solders directly to the PCB and should be fitted last. Leave pins 1 to 8 unsoldered until you've confirmed the system works. The photos of the transmitter show a close-up of the PCB and how the case assembles.

The transmitter is powered by a 12V alkaline battery. Take care to fit the battery the right way around, as the battery contacts are not polarised. When the battery is fitted, you should see the LED pulse brightly when either button is pressed. Note that the brightness of the LED has no bearing on the tuning of the transmitter.



Here's the layout for the receiver/decoder PCB shown actual size for those who wish to etch their own boards.

Receiver/decoder/relay PCB

The layout for this board is shown in Fig.4. Start by fitting the wire links, then solder the resistors, diodes and capacitors in place. IC sockets were used in the prototype, but are optional. If you are using sockets, fit them next, then solder the transistors and the voltage regulator in place.

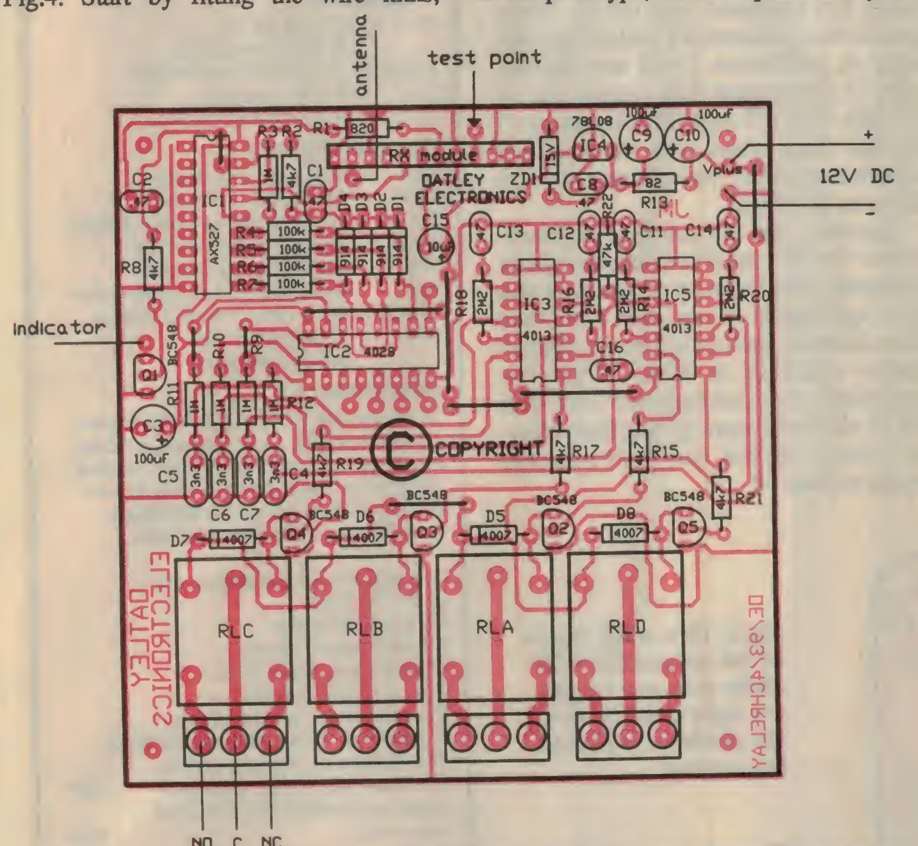


Fig.4: The layout for the receiver/decoder PCB is shown here. The receiver module solders directly to the PCB with the components facing in. Fit the links first, then follow with the passive components.

Before fitting the receiver module and the ICs, it's a good idea to check the power supply section. With 12V DC connected to the board, confirm that the output of the regulator is 8V DC.

Then solder the receiver module in place, arranged so the component side faces in. Then fit the ICs and the relays. Also connect a 250mm (or so) length of wire for the antenna. As with the transmitter, leave the address pins of IC1 open-circuit.

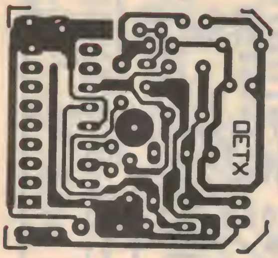
Testing it all

To test the system, connect 12V to the board. All relays should remain off, due to the power-on reset circuit. Hold the transmitter close to the receiver module and confirm that relay A operates when pushbutton 1 is pressed. You should hear the relay click on. Remember each press of the transmitter button toggles the relay.

Repeat the test for relays B and C. Relay D can only work with a modified transmitter, as we'll explain shortly. If the system doesn't work, check the test point of the receiver. The signal should be digital data, at a relatively low frequency and with a peak value of around 4V. All receiver modules have been tested, so if you are not getting an output suspect the transmitter.

If there is an output, monitor pin 17 of

Four channel remote control



And here's the actual size board for the transmitter PCB, also for those who like to etch their own boards.

IC1 with a voltmeter and check to see if this terminal switches high (about 8V) when a transmitter button is pressed. If not, try adjusting the transmitter tuning. If pin 17 does switch high, check the inputs to IC2 to see if they change from 0000 to the transmitted code.

Using the system

Once the unit is functioning, it remains to adjust the transmitter and code the trinary encoder and decoder ICs. Preliminary adjustment of the transmitter can be done by holding it a few metres from the receiver and adjusting the trimmer capacitor (with a non-magnetic screwdriver) to get reliable operation of the relays. Fine tuning can then be done from a distance of 100 metres or so.

If you have an AC voltmeter (analog or digital), you can also use the receiver test point to tune the transmitter. Select the lowest AC voltage range on the meter and connect it between the test point and common. Hold the transmitter a few metres from the receiver (to avoid overload) and adjust the trimmer capacitor to get a peak reading on the meter.

To set the address of the trinary encoder and decoder ICs, you need to connect each address pin to either the supply voltage (logic 1), ground (logic 0) or leave the pin disconnected. On both PCBs, there are two tracks, one connected to ground and the other to the supply voltage, near the address pins of the trinary encoder and decoder ICs. Choose an 8-bit code, and connect the relevant address pins as required. The address pins for both ICs are pins 1 to 8.

The indicator output transistor on the receiver/decoder/relay board can drive a buzzer, lamp, a LED or anything within the specifications of the transistor. This transistor pulses on while a transmitter button is pressed.

Note that while the relays supplied with the kit are rated to switch a 240V appliance, the PCB layout is not.

If you want to switch 240V appliances, we recommend you either remove the relays and mount them on a suitable PCB, or use the relays to operate another suitably rated relay. The reason is the PCB design is not intended to have 240V applied to any point. Using an off-board, mains-rated relay solves this. The relays supplied with the kit also have a contact rating of 12V/12A.

The fourth channel

To get the fourth channel, you need to cut the track to pin 12 of IC1 in the transmitter and reconnect it to pin 11. When you do this, pushbutton 1 will still operate relay A, pushbutton 2 will now operate relay D, but pressing both buttons will set Q5 (pin 6) of IC2 high. That is, you can't operate three relays with the modified transmitter unless you connect a relay driver to Q5 of IC2.

However, you can purchase the transmitter or the receiver/decoder parts separately, and make up a system to suit your application. If you want more than four channels, don't forget the 12-channel system described in March 1993. The transmitter described here will work with the 12-channel system (giving three channels only), so you can even mix and match systems. ❖

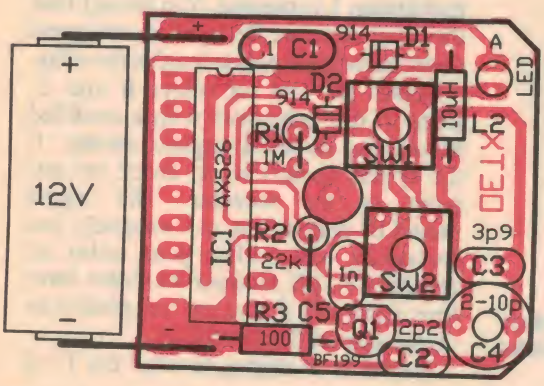


Fig.3: This is the layout of the transmitter PCB. Make sure you've got the right orientation for the diodes, the IC and the battery.

PARTS LIST
Transmitter:

Resistors

All 1/4W:

R1	1M
R2	22k
R3	100 ohm

Capacitors

C1	0.1uF monolithic
C2	2.2pF ceramic
C3	3.9pF ceramic
C4	2-10pF trimmer
C5	1nF ceramic

Semiconductors

IC1	AX526 trinary encoder
Q1	BF199 NPN transistor
D1,2	1N4148/1N914 signal diodes
LED	5mm red LED

Miscellaneous

Silk-screened PCB, 35 x 32mm; 2 x momentary-on pushbuttons; 10uH inductor; 12V battery and battery PCB contacts; suitable plastic case.

Receiver/decoder:

Resistors

All 1/4W:

R1	820 ohm
R2,8,15,17,19,21	4.7k
R3,R9-R12	1M
R4-R7	100k
R13	82 ohm
R14,16,18,20	2.2M
R22	47k

Capacitors

C1,2,8,11,12,13,14,16	0.47uF monolithic
C3,9,10	100uF/25V electrolytic
C4-7	3.3nF ceramic
C15	10uF/25V electrolytic

Semiconductors

ZD1	15V, 1W zener diode
Q1-5	BC548 NPN transistor
D1-4	1N4148/1N914 signal diodes
D5-8	1N4004 1 amp diodes
IC1	AX527 trinary decoder
IC2	4028 CMOS 1-of-10 decoder
IC3,5	4013 CMOS dual D flipflop
IC4	78L08, 8V TO92 voltage regulator

Miscellaneous

Silk-screened PCB, 100 x 95mm; prealigned 304MHz UHF receiver module; 2 x 14-pin IC sockets; 16-pin IC socket; 18-pin IC socket; 4 x 12V PCB mount relays; PCB mount screw terminals; tinned copper wire; hook-up wire.

Kits of parts for this project are available from:
Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985
Postal address (mail orders):
PO Box 89, Oatley West NSW 2223.

Transmitter kit, all components, silk-screened PCB and case...	$22
Receiver/decoder/relay PCB kit, complete...	$74
P&P...	$ 4

Initiation

Continued from page 17

my friendship group was shrinking into an eccentric elite.

As if learning a new language at my age wasn't enough, I also had to learn new ways to count. Not one new way, but half a dozen different number systems. I mean, why count in colours, when numbers have always been good enough for everyone else? Because technicians like to be initiated into secrets, of course. That's why.

There were also hieroglyphics on capacitors, and every type of Integrated Circuit had a different number system depending on which manufacturer was trying to keep technicians dancing on their toes. What's more, if one IC was powered up from leg 8, you could be sure the next one would use leg 14.

Not only were components to blame. Computers, for all their glorification in the modern electronics evangelism, are notoriously dumb. Why, they can't even count up to 10 like us. They demand new number systems like binary and hexadecimal. All more brain teasing, for the poor belaboured electronics trainee.

I have survived

I am pleased to report that I have survived. The solder ~~burns~~ have healed, and the pieces of an exploding electrolytic capacitor have been surgically removed from my brow. A series of minor shocks have realigned my brain, and yesterday a neighbour asked me to fix her silent Walkman. It now blasts her ears again. My multimeter spoke to me, and revealed that I should clean the lemonade off her battery terminals.

Now I am finally qualified to deliver a techo talk sermon to the assembled masses. So here it is:

Yea, and I say unto you — Resistors in Parallel do not form Darlington Pairs. This is because in a power amp circuit there is a Common Mode Rejection Ratio which keeps them apart. However Internal Frequency Compensation allows for the formation of Integrated Circuits into Logic Families. These logic families are made up of individuals who resemble nothing so much as a cockroach.

And yea I say unto you, it is they who have inherited the earth and you are but their humble servants. It is I who know how to connect their little legs to the power supply and make them work. Therefore worship at my temple, for I am an electronics technician. ❖

THE SERVICEMAN

Continued from page 45

8mm movie films, much older than the videotapes, showed no such deterioration, and asked just how long videotapes might be expected to last. It was the same sort of question that my customer raised five years later, and I might have part of the answer for both of them.

I bought my first VHS recorder on December 3, 1981. It was an AWA ATV4 and among the included accessories was a one-hour sample tape. That same night, the ABC broadcast a documentary covering James Galway's concert tour of Japan. The sample tape was just long enough to accept the film, so I made that my very first 'off air' recording.

The result was all that I could have hoped for, and I have kept the tape and have viewed it on a number of occasions since then. (Yes I know about copyright, but this tape is a personal record and has never been seen by anyone but me.)

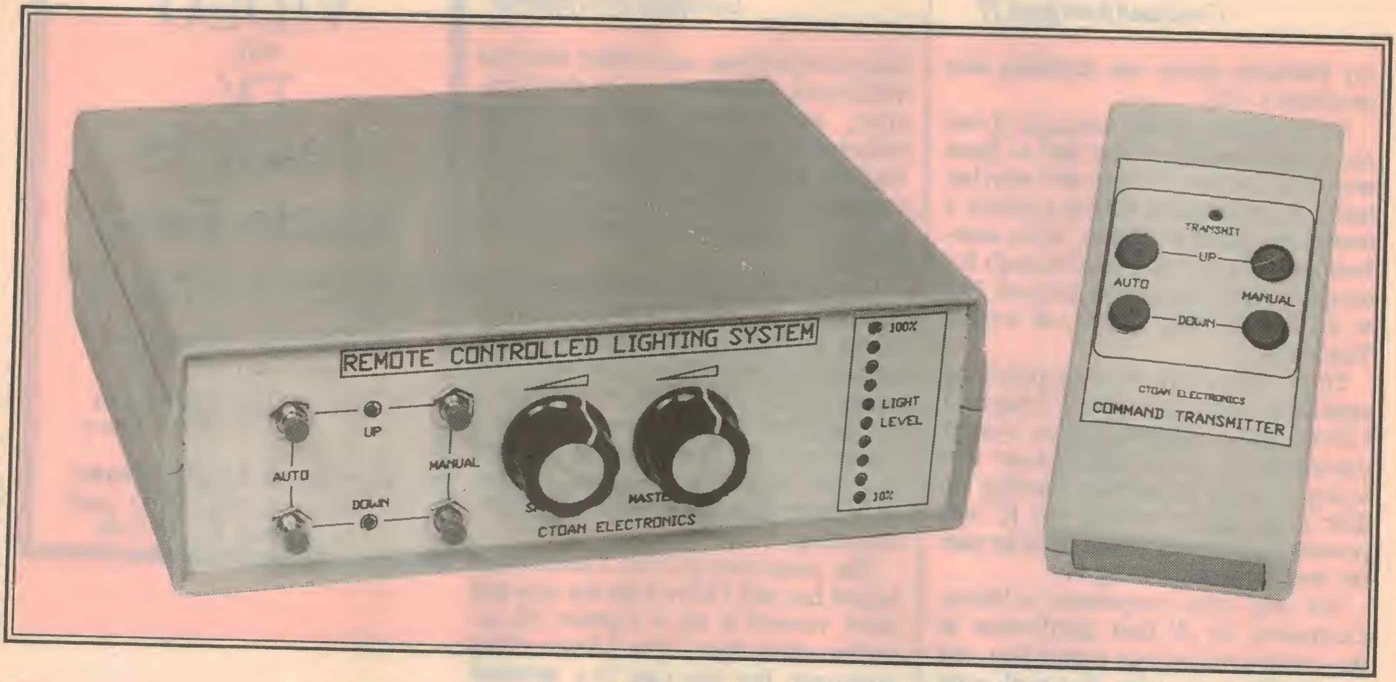
Last night, I pulled out the nearly-12 year old tape and played it once more. I could not see ANY sign of deterioration, in spite of all the years that have passed since it was recorded.

I feel that this is sufficient evidence that videotapes will last for a very long time indeed, given clean and cool storage. Occasional rewinding may well be advantageous, but my tape was rewound no more often than once every two years and it is still in perfect condition.

I can't speak for 8mm movies, since I have no samples for comparison. However, I do have many hundreds of 35mm, 2-1/4" square and 4" x 5" colour transparencies dating back to the 1950's. The colour in the oldest of these has deteriorated quite markedly, but it seems to have held up well enough over time spans similar to the video tape mentioned above.

It will be interesting to see how videotape survives over 40 years, but I had no hesitation in telling my customer that his tapes will survive very well over periods of 10 to 20 years, provided that they are carefully stored and only played occasionally, on a machine known to be in good order.

So, with those words of wisdom I'll sign off for another month. There are still a few interesting stories left in the contributor's basket, but there's always room for more. ❖



Remote controlled Light Dimmer - 1

This light dimmer has the lot. It can control up to 2400W of lighting, it has automatic and manual fade-up and fade-down, and a 'light level' bargraph. But best of all, it's remote controlled — with a neat radio-frequency (not a directional infrared) handpiece. This month we look at how it works.

by JEFF MONEGAL

Light dimmer designs are not new to *EA*, and the predecessor to this project was published about 18 months ago. However, a good look through the *EA* project database confirms that we have not so far described a *remote-controlled* light dimmer.

A remote-controlled dimmer would be regarded by some as a luxury, although there was a time when a light dimmer of any sort was seen as a luxury. But considering virtually everything electronic these days has a remote control, a remote-controlled dimmer seems rather overdue.

So why has it taken so long for one to be described in *EA*? There are several reasons, but basically such a device has previously been too complex and expensive. However, these days a multi-channel RF remote control system is relatively cheap and small, allowing it to be easily interfaced with an electronic light dimmer.

Of course the electronic light dimmer itself is the key part of the project and this project is based around the dimmer section of the already proven Multidim (June 1992). The remote control section interfaces with a simple digital to analog converter (DAC), to produce the DC voltage that controls the dimmer.

An alternative method to control a DC voltage remotely is to use a motor attached to a variable resistor; a method often found in amplifier volume controls. Or perhaps a sample-and-hold circuit, with a very low-leakage capacitor and a very high impedance op-amp. But both of these methods are relatively expensive and difficult to implement, as the components are critical and hard to get. Hence the decision here to use a DAC.

The total cost of the unit is around $160, although if you have most of the bits, you can buy a short-form kit for less than $70. Considering a commercial remote control unit (if you can find one) costs many hundreds of dollars, we think this project represents excellent value.

The project

This unit combines part of the popular Multidim light dimmer and a compact radio-frequency remote control system. As the lead photo shows, the dimmer unit is fitted inside a box and has four pushbuttons and two controls. The remote control handpiece duplicates the four pushbuttons fitted to the dimmer.

The pushbuttons provide either automatic or manual fade-up and fade-down. The rate of fade is set by the 'speed' control, and the maximum brightness is

set by the 'master level' control. Pushing the auto-up button causes the lights being controlled by the dimmer to increase in brightness at a rate set by the 'speed' control. This rate is adjustable from almost instantaneous to an hour or more.

The 'master level' control sets the maximum brightness of the lights. This means the lights will increase only to the level set by this control, which can be anywhere from fully off to fully on. Therefore this control can also be used for manual dimming.

Pressing the auto-down pushbutton will cause the lights to fade to fully off, again at a rate set by the 'speed' control. There is no front panel minimum-brightness control, but there is an internal adjustment that would normally be set so the lights completely extinguish. You can use this internal control to set the minimum brightness to any level you wish.

The manual pushbuttons cause the lights to change brightness while either button is pressed. The rate of change is still determined by the 'speed' control, but you can stop the change by releasing the button. Again the maximum brightness is set by the 'master level' control.

The remote control unit duplicates the four pushbuttons just described. Because it's a radio-frequency controlled system, you can even operate the dimmer from another room. In other words, you don't have to point the control at the dimmer unit.

A feature of the unit is that it can control loads up to 2400W, depending on the size of the heatsink. Most readers won't need this power handling capability, and the basic kit includes a heatsink that allows the triac to control about 1200W of lighting.

Another important feature is safety, and all the electronics for the controller are powered from a transformer rather than directly from the mains. The triac and the RF filter components are of course at mains potential, but none of these components is on the printed circuit board, making the PCB relatively safe to work on.

How it works

We'll describe the circuit in two parts: the dimmer section, and the part which develops the voltage that controls the dimmer and therefore the lamp brightness. First the dimmer section.

Transformer T1 supplies 12.6V AC to the bridge rectifier of D1 to D4. The DC output is filtered by C1 then regulated by IC1, an 8V three-terminal regulator that gives an 8V DC supply rail for the rest of the electronics. To achieve a smooth control, a ramp waveform, synchronised to the zero-crossing points of the AC mains waveform, is used in conjunction with the control voltage from the rest of the circuit.

Resistors R1 and R2 tap off a portion of the voltage applied to the rectifier. This voltage has the same shape as the output of a full-wave rectifier, and R3 connects it to Q1.

When this voltage is less than +2V or so, Q1 is turned off and R5 pulls the collector voltage high. Otherwise Q1 is on. The voltage at the collector of Q1 is therefore a series of 1ms wide pulses, spaced by 9ms (frequency of 100Hz). When Q1 is off, Q2 is on and capacitor C4 is quickly discharged. This is the starting point of the ramp voltage.

When Q1 turns on, Q2 turns off and C4 now charges linearly via the constant current source made up of Q3 and associated components. The base voltage of Q3 is held at around 6V by the 2V drop across LED1. This gives a constant voltage of 6.6V at the emitter and therefore a voltage drop across R7 of around 1.4V. The charge current for C4 is therefore about 80uA (1.4V/18k).

The constant current charges the capacitor, giving a linear change in the voltage across C4 as it charges, rather than the usual exponential change. The peak to peak value of this waveform is around 4V.

The ramp voltage is connected to pin 3 of IC2 via R8, together with the output of IC9 supplied via R9. The voltage present at the non-inverting input (pin 3) of IC2 is therefore the resultant of both the instantaneous value of the ramp voltage and the value of the voltage supplied via R9. For example, if the ramp voltage at a particular instance is 2V and the voltage via R9 is also 2V, their combination will give 2V at the input. When the ramp is zero (and the control voltage is 2V), the input to IC2 will be 1V, as both R8 and R9 have the same value.

A reference voltage is applied to the inverting input of IC2 with the preset potentiometer VR1. This voltage sets the operating point of the comparator of IC2 and is the adjustment to make the lights turn fully off.

When the voltage at pin 3 (positive input) exceeds the reference voltage at pin 2 (negative input), the output of IC2 will be high. This turns on transistor Q4, causing the LED in the opto-coupler of IC3 to light. As a result, the triac turns on, as gate current can flow through R13, R14 and the light-sensitive diac in IC3.

Similarly, if the voltage at pin 3 of IC2 is less than the preset voltage at pin 2, the output of IC2 will be low. Thus Q4, the opto-coupler and the triac are off.

In summary, the triac is turned on at a particular point on the ramp voltage, depending on the value of the control voltage supplied by R9. Because the ramp is synchronised with the mains, the triac is phase-controlled by the circuit. The triac turns off after each half cycle when the load current falls to zero.

R13 and R14 together with C8 form a 'snubber network' across the triac. RFI

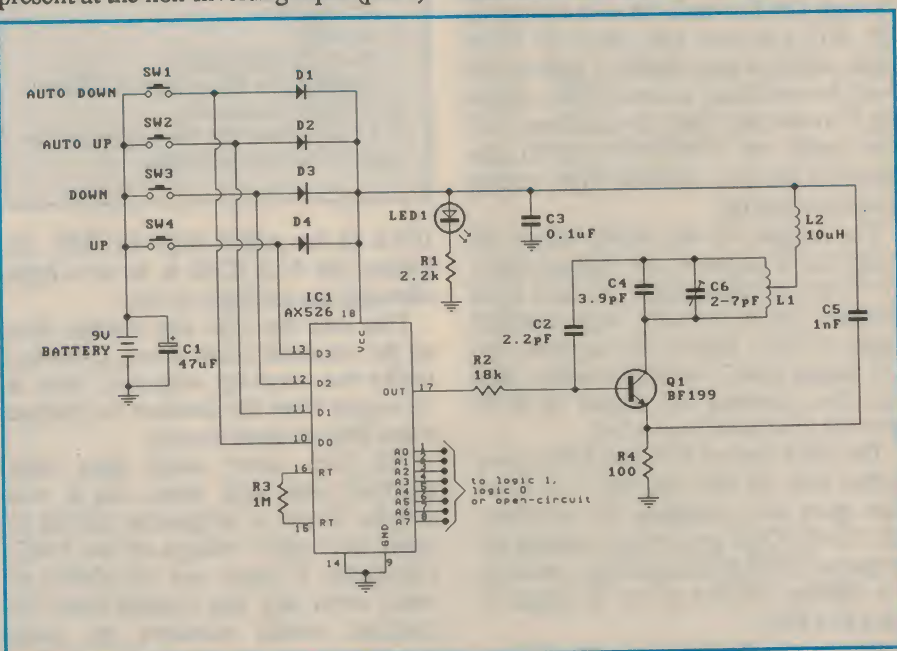


Fig.1: The transmitter comprises a 304MHz oscillator around Q1, keyed by the binary signal at pin 17 of the trinary encoder IC1.

suppression is provided by C9 and the toroid L1.

The control voltage

The control voltage is produced at the output of IC9, which is a buffer for the voltage developed by a DAC comprising the R-2R network of resistors R18 to R33, driven by counters IC7 and IC8. The counters are clocked by the oscillator around IC6B.

The two up-down counters of IC7 and IC8 count in binary, giving 256 levels. The output of the R-2R ladder therefore varies from 0V to +8V in 255 steps, and this voltage is filtered by C13, then buffered by IC9.

Flipflop IC5A controls the automatic fade-up. A positive-going pulse from either SW1 or the remote control section (IC12A) will toggle the flipflop (assuming the reset terminal of pin 4 is at a logic 0). This is because the Q-bar output of the flipflop is fed to the D input, via the time delay network of R37 and C14.

Let's assume the Q output (pin 1) of IC5A goes high in response to a positive pulse on its clock input (from either SW1 or IC12A). D7 will now be forward biased, causing Q5 to turn on via R16, lighting indicator LED12 (UP indication).

D8 will now be reverse biased as its cathode voltage will equal its anode voltage. It was forward biased before by R17, with a very small current flowing through D8, R16 and the base-emitter of Q5. R17 can now pull pin 1 of IC4A high, which in turn applies a high to pin 6 of the oscillator around IC6B, allowing it to run and clock the counters. R17 also pulls the UP/DOWN (U/D) terminal of the two counters high, setting them to count up.

The output of the DAC ramps up while the Q output of the flipflop (pin 1 of IC5A) remains high, or until both counters have reached their terminal count of 255. When this happens, the CO output (pin 7) of both counters falls to a low, causing the output of IC4D (pin 11) to also become a low.

The U/D line of IC7 and IC8 is now pulled low via D9, and pin 1 of IC4A also goes low, stopping the oscillator. Pin 10 of IC6C goes high, causing the output of IC4C to also go high, resetting the flipflop (IC5A) so its Q output is back to a low.

This means the DAC output will stop when its maximum count has been reached. Further pressing of either SW1 or its companion button on the remote unit will do nothing.

The fade-down sequence is rather similar. If SW3 or the auto-down button on the remote is pressed, pin 13 of flipflop IC5B will go high. D11 is then forward biased which turns on Q6, lighting the DOWN LED (LED13). D12 is now reverse biased, allowing pin 2 of IC4A to be pulled high by R39. As before, pin 6 of IC6B is set to a high, allowing the oscillator to run.

This time the U/D line remains low, so the counters count *down*. However, unlike the count-up sequence, there is no output from the counters to indicate when they are back to zero.

The zero count could have been decoded with logic gates, but it was simpler to use a comparator (IC10) to sense the output voltage of the DAC. Obviously, if there was no circuit to sense when they had reached zero, the counters would continue to cycle through the count until they reached a maximum. Hardly what we want!

So, as the output of the R-2R network falls, so does the voltage at the positive input (pin 3) of IC10. This op-amp is connected as a comparator and compares the output of the DAC to the voltage on the negative input (pin 2). This voltage is adjustable with VR4 and is fairly critical. It is adjusted so the output of the DAC can go as close as possible to zero without snapping back to a maximum.

When IC10 detects that the DAC output is zero, its output goes low. This stops the oscillator by pulling pin 2 of IC4A low (via D13). Flipflop IC5B is also reset through IC6D and IC4B.

Manual operation is with SW2 and SW4 (and the corresponding remote control buttons via IC12D and IC12C). These make the circuit function as already described, except the flipflops of IC5 are not involved. Instead, the logic 1 normally provided by the Q output of either IC5A or IC5B comes from the pushbuttons. Therefore, the oscillator will operate as long as a manual pushbutton is pressed, or until the counter is either a maximum or a minimum.

The speed of the fade change is set by the front panel control VR2. This control sets the speed of the oscillator, and gives a counter cycle time that ranges from about one second to over an hour. The master level control is VR3 and sets the value of the control voltage applied to the dimmer section via R9. Although not essential to the operation of the dimmer, a 'light level indicator' has been included, using the popular LM3914, 10-LED bargraph driver IC.

The control voltage applied to the dimmer section is also connected to the input of IC13, which lights LEDS 2 to 11 in bargraph fashion. Each LED shows a 10% change in the control voltage, and therefore a 10% change in brightness of the lights controlled by the dimmer. This circuit is calibrated by VR5. The setting is not critical, and should be set so the LEDS follow the brightness of the lamps controlled by the dimmer.

Remote control

The UHF remote control section is based around the trinary encoder/-decoder ICs type AX526 and AX527. These ICs have featured before in other remote control units described in *EA*, and for more information refer to the March 1993 issue, where a 12- channel remote control unit was described. In fact, it's possible to use this 12-channel transmitter with the dimmer, although extra decoding is needed.

The circuit of the transmitter is shown

Continued on page 103

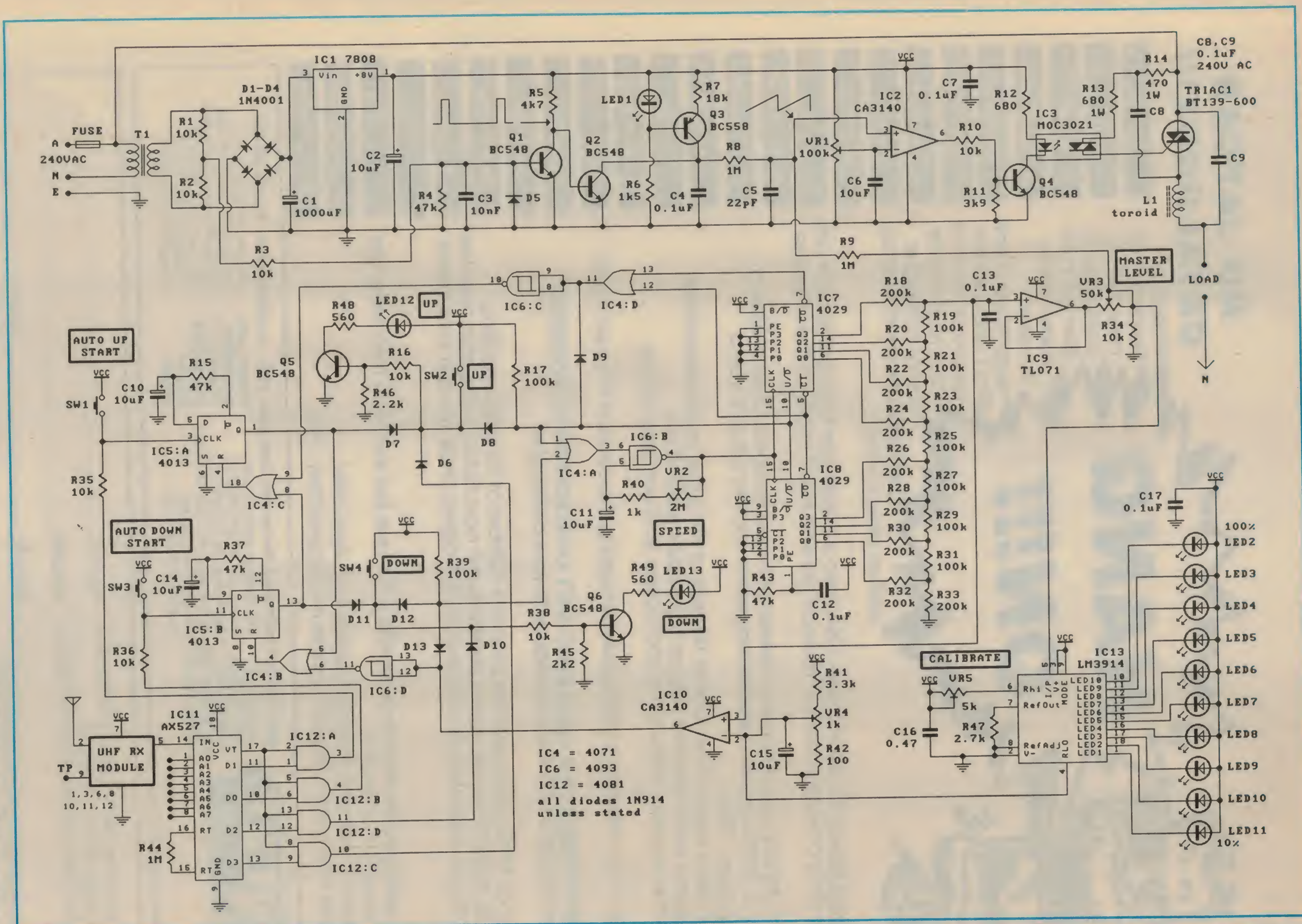
Available as a kit

This project will be available as a kit from CTOAN Electronics. The cost of a complete kit that has all parts, including cases for the transmitter and the dimmer is $159.95, plus $10.00 P&P. A short-form kit is also available, which contains the AX526 and AX527 ICs, both PCBs, the UHF receiver module, 2 x CA3140 op amps, the toroid and winding wire and a BF199 transistor. Cost of the short form kit is $68.95 plus $8.00 P&P.

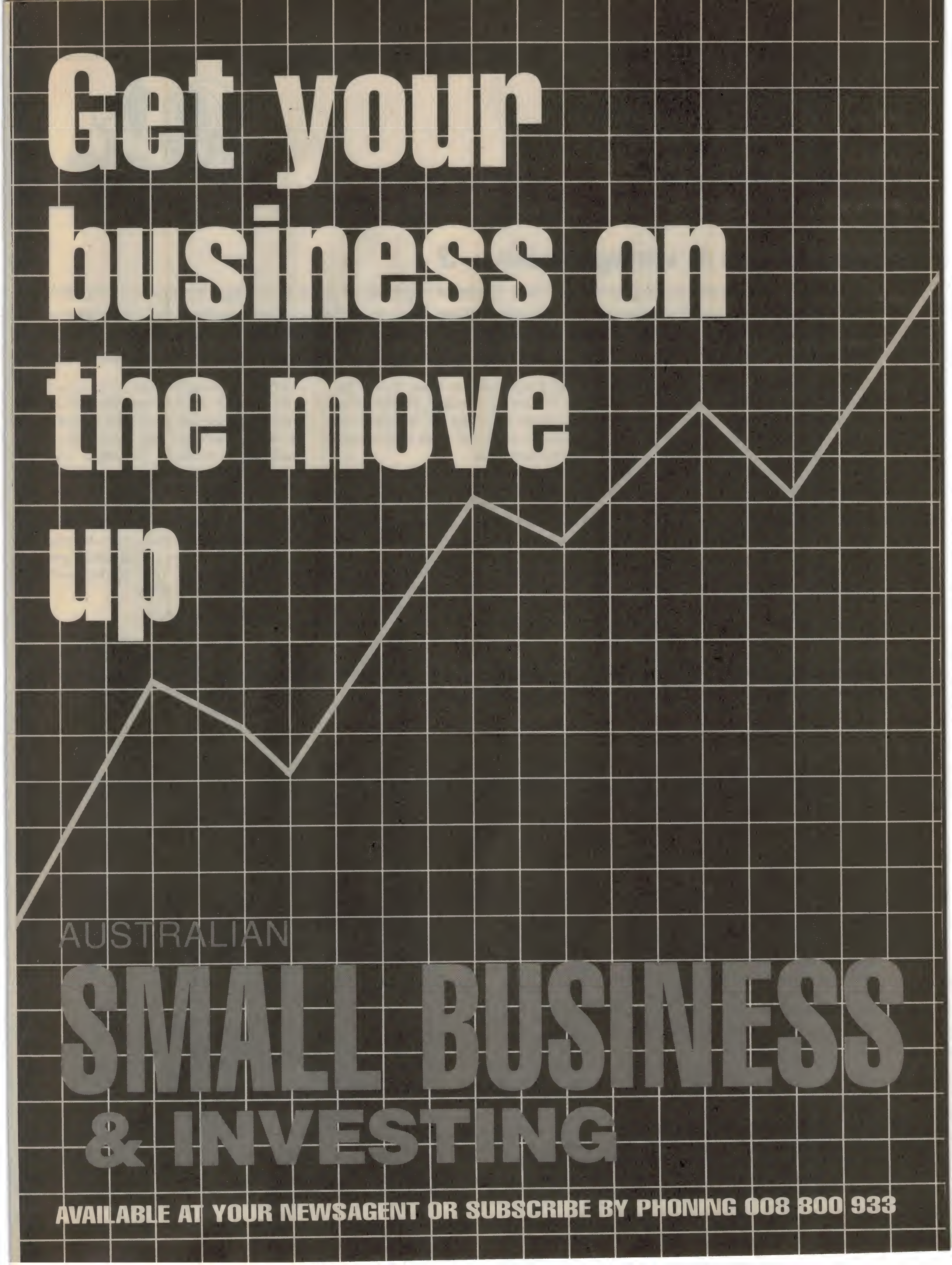
CTOAN Electronics also offers a full backup and repair service for the kit. Maximum cost of any repair is $45.00 including return postage. CTOAN reserves the right to refuse repair on a kit that has been badly soldered or constructed. CTOAN also offers ready-built and fully tested PCB assemblies for the dimmer and the transmitter for a cost of $75.00. We regret that CTOAN Electronics cannot provide completely built-up and tested versions of the kit.

Order or phone:
CTOAN Electronics
PO Box 211
Jimboomba
Qld 4280
Phone (07) 297 5421

A full parts list for the project will be given in the second article.



The circuit diagram of the dimmer. Synchronising pulses are derived from the mains by Q1, which locks the ramp developed across D4 to the mains frequency. This ramp voltage is combined with the voltage developed by an 8-bit DAC to control the conduction time of the triac.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Vintage Radio

by PETER LANKSHEAR

Capacitors in vintage radio — 3

Lately we have been looking at the various types of capacitors used in vintage equipment. Such is their importance, and their range so comprehensive, that, to provide even a superficial coverage of the subject we have run into an unprecedented third section. This time we look at semi-variable or 'trimmer and padder' capacitors, and then at the practicalities of capacitor repairs and replacement.

This month we provide some capacitor restoration hints for inexperienced readers. But first, left over from last month are some comments about the all important semi-variable preset *padders* and *trimmers*, essential for receiver alignment. (By the way, a *padder* is a preset variable capacitor with a relatively high value, used mostly to achieve the tuning offset for the local oscillator section of a superhet receiver. *Trimmers* are preset variables of lower value, used for fine adjustment of tuning and tracking.)

Several representative types are shown in Fig.1, but it should be realised that these are only a fraction of the number of patterns likely to be encountered. In the top row are two varieties of the superior air dielectric trimmers found in the highest grade equipment, especially test and military equipment and communication receivers. The trimmer at the top left is in reality a small conventional variable air spaced capacitor with a screwdriver slot and locknut instead of a knob. These will often be found in the coil boxes and IF transformers of the classic communications receivers.

One of the most successful air trimmer designs was the remarkable concentric 'Beehive', illustrated in the top centre and right in Fig.1 and produced by Philips over a period of at least 40 years — and possibly longer. They consisted of two sets of concentric mating cylinders, with one mounted on a coarse threaded centre rod so that its cylinders could move between the fixed set. The only insulation necessary was a ceramic sleeve section on the rod.

With air dielectric, and ceramic insulation, concentric air dielectric trimmers were very efficient and stable. Other manufacturers appreciated their worth, two diverse examples being Britain's Eddystone in their communication receivers and New Zealand's Radio Corporation in some 'Columbus' and 'Courtenay' models. Philips at one stage even scaled up the concentric capacitor to make full scale three-ganged tuning capacitors!

Very familiar are the compression preset capacitors, and a typical padder of this type is shown at the bottom left of Fig.1. Most have a ceramic body, with electrodes and dielectric, usually mica, interleaved like the pages of a book. A simple screw adjustment controls the pressure on the plates. Many tuning capacitors have integral compression trimmers of this type. This class of capacitor is generally satisfactory for medium waveband receivers, but for good shortwave performance, trimmers with better temperature stability are desirable.

For critical applications, especially oscillator tracking, ceramic trimmers with a negative temperature characteristic are preferable. One common pattern is the rotary type shown in the lower centre of Fig.1. At the bottom right is an earlier type used by Philips in the 1930's. It consists of a thin ceramic tube, with a coating of silver on the inside. The other electrode is a single layer of tinned soft wire wound on the outside and cemented. Adjustment procedure is simple: the wire is unwound until the correct capacitance is reached. Of course, what happens in real life is that the unwinding goes past the optimum point, and some of the wire then has to be rewound and fastened in position! For production alignment these trimmers were satisfactory enough, but over-enthusiastic experimenters can get into bother with repeatedly adjusting them.

Renew or repair?

A significant part of restoration work involves capacitors. There are several philosophies as to the best approach, but if you have any doubts about your ability to restore a valuable receiver, remember that it is all too easy to devalue equipment by thoughtless servicing. If there is any doubt or difficulty, my advice is — don't do *anything*. An inoperative veteran receiver in original condition is more valuable than one made workable by ill-considered substitution of irreplaceable components. Generally, the

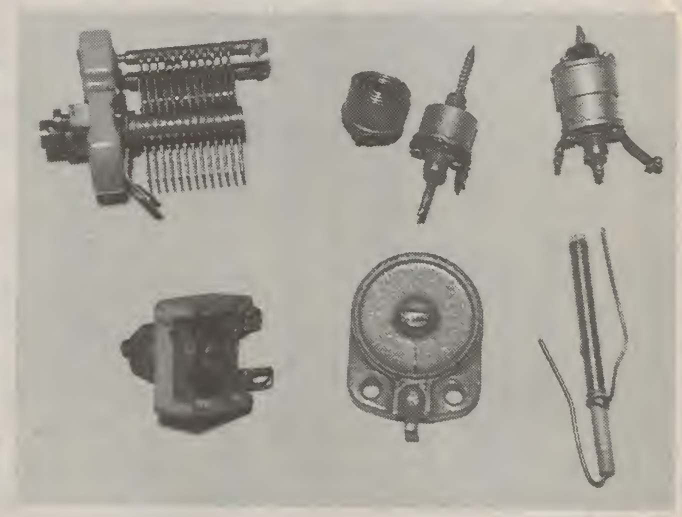


Fig.1: A selection of small variable 'trimmers' and 'padders'. At top left is a high grade air-spaced type, with examples of Philips' very successful 'beehive' concentric air trimmer at top centre and right. A mica compression padder is at lower left, then a ceramic trimmer and finally a tubular ceramic type.

older the equipment, the greater the importance in maintaining originality.

The hints that follow do not apply to very old receivers — which used very few fixed capacitors anyway — but are intended for those made after about 1930 when standardised proprietary components came into common use. A complicating factor is that previous servicing work may have to be remedied.

Several philosophies...

There are several philosophies in dealing with small components. At one end of the scale, the attitude is that, as they are out of sight under the chassis, all electrolytic and paper capacitors, regardless of condition, should be replaced with modern equivalents.

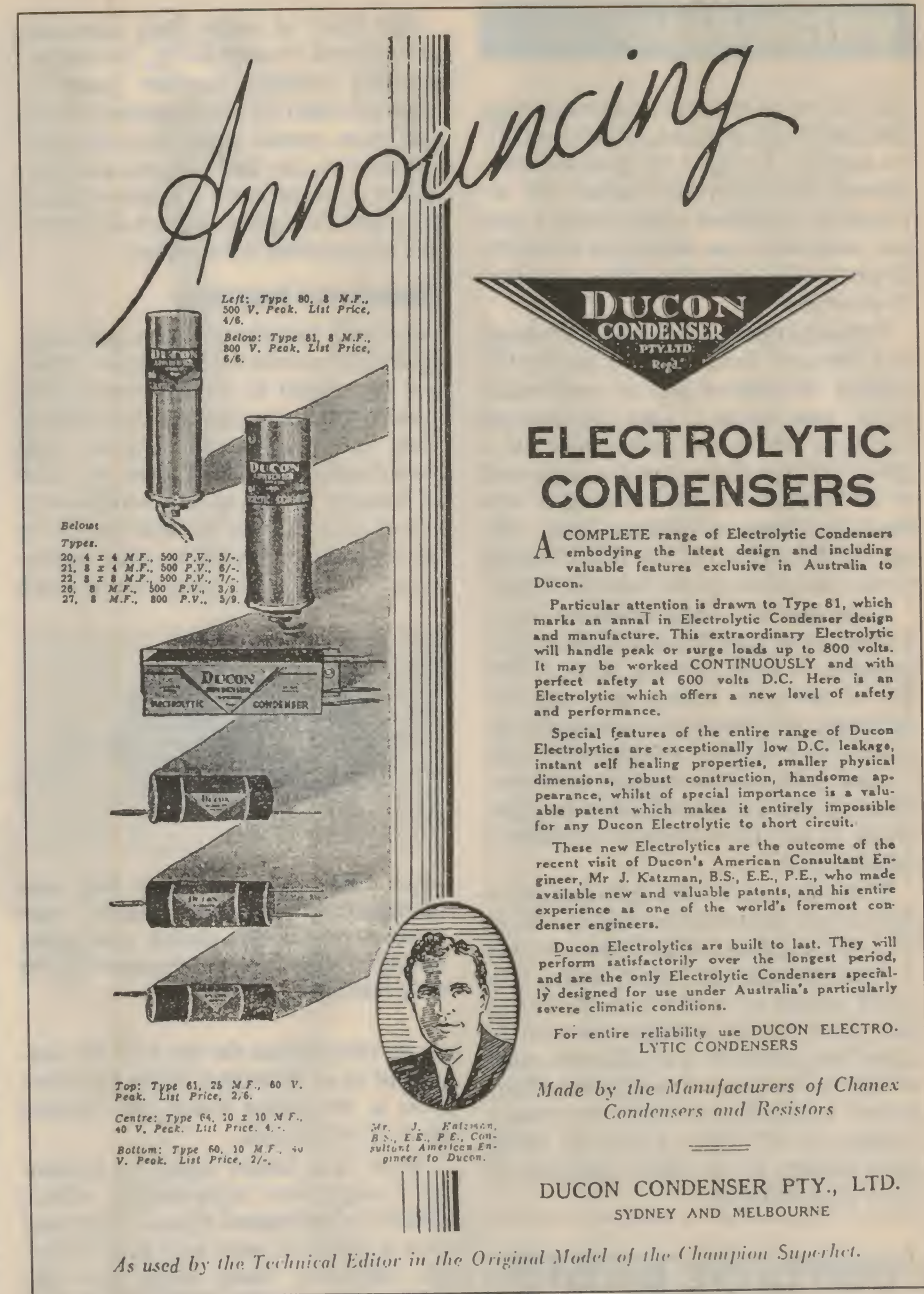
Probably the majority of restorers work on the less extreme principle of replacing only those capacitors which have failed, or are in critical locations. Some are content to use replacements 'as is'. Sticklers for originality and correctness go to considerable lengths to obtain genuine replacements, and in some instances, repair faulty capacitors, or renew the contents of the original cases. Especially distinctive components may be left in position, with a modern replacement, which is invariably smaller, placed alongside. Meticulous conservators will carefully document all work.

A good place to start is with the electrolytic capacitors. Vintage electrolytic capacitors had a limited life expectancy, and there may have been several generations used in a veteran receiver during its life. Ascertaining their exact condition can be a problem. They can dry out and lose capacitance, and consequently some method of measuring them is desirable.

For the old-time serviceman, who regarded even a good test meter as a luxury, a capacitor tester was but a dream. Consequently, rough and ready empirical methods of testing were developed. Capacitance could be estimated by the size of the 'splat' when a charged capacitance was short circuited, and leakage was judged by the length of time a charge was held after the power was turned off!

Many digital test meters have a useful capacitance measuring facility, but as many cannot measure a very wide range, a capacitance bridge is a valuable tool for the serious restorer. This does not need to be an elaborate instrument, and a suitable home-built unit was described in *Electronics Australia* for February 1991.

A most critical capacitor application is that of the filter immediately following the rectifier. In earlier receivers this was often a chassis-mounting wet type which is likely to have long since dried up, and



Sixty years ago, Australia had a thriving capacitor industry, as shown by this advertisement from the July 13, 1934 issue of 'Wireless Weekly'. Ducon and Chanex capacitors can still be found in many receivers from this period.

in all probability there is now a tubular dry type already fitted as a replacement. Repairs are impractical, and the positive terminal may have been used as a tie point for several other components.

Normally, unused wet electrolytics are disconnected and left in position for appearance. The simple approach is to connect the leads to an insulated tie point mounted on the capacitor's terminal and substitute a dry electrolytic capacitor. In many circuits, to provide a bias supply, the negative terminal of the capacitor is insulated from chassis.

Some enthusiasts use skill and ingenuity in enclosing the replacement capacitor inside the old can. One method that may work is to uncrimp or grind down the swaging around the base. Another method is to cut the can in two near the base, remove the contents and with the replacement capacitor installed inside, turn up a wooden mandrel the diameter of the original can. The mandrel, with a suitable hole for the leads, is then used as a sort of splint to rejoin the two sections of the can. A paper sleeve or the original label can hide the join.

There are some important points to note in selection of replacement capaci-

tors. Do not be tempted to use extra large filter input capacitances, or valve rectifiers may be damaged by peak currents. Several interdependant factors are involved in individual cases, but as a general rule, don't use more than twice the original value, and then with a top limit of about 40uF.

Failure to observe this rule could result in a damaged rectifier valve, excess HT voltage developed and an overheated power transformer. I have encountered instances where the substitution of a 100uF TV type filter capacitor connected to the rectifier cathode has resulted in a burnt out power transformer. Large values at the *output* of the hum filtering system do not create the same problems.

There are two characteristics of electrolytic capacitors that are of special importance in hum filtering service. The first is the peak voltage at switch on. Although valve receivers commonly operate with 250 volts of high tension, the no-load voltage at the cathode of the rectifier can be considerably higher, especially if the filter system includes a speaker field.

When the set is first switched on, a filamentary type rectifier such as a 80 or 5Y3 will conduct within a few seconds — but the indirectly heated valves take a half minute or so to warm up. During this period, the voltage can rise to something like 40% more than the rated voltage of the power transformer. Many power transformers had a secondary voltage of 385 volts, giving an initial peak voltage at the input capacitor of more than 500 volts.

The label on some filter capacitors gives a peak or surge rating, as well as a working voltage. Another parameter often provided on filter capacitors is the maximum current rating. In some applications, this can be an appreciable fraction of an ampere, but it is impossible to give specific figures and not all capacitors are provided with a rating.

Check for heating

As many technicians and experimenters have discovered, electrolytic capacitors can object to voltage and current overload in a most spectacular manner! They may overheat and explode with considerable force, and there are tales of damage to wiring and components, and of the remnants of capacitors being left on ceilings. Therefore, after replacing a filter capacitor, keep a close watch on its temperature for the first 10 minutes or so of operation. If the capacitor feels to be getting warm, the chances are it is not suitable.

Fig.2: The cases of hard wax and composition jacketed paper capacitors frequently shrink and split, letting in moisture. Replacement is the only remedy.

There is a further aspect of electrolytic capacitor replacement which should be mentioned. Capacitors stored over a period of years may need dielectric reforming. Some testers have this facility, but a simple method is to connect the capacitor via a current-limiting resistor across a voltage source comparable with the rated voltage. A value of 1k ohms per volt is suitable for the resistor, and progress is readily monitored with a voltmeter. Initially, the reading may be low, but when reforming is complete, there will be practically full voltage across the terminals.

Many vintage receivers had only two electrolytic capacitors, both used for HT filtering. More elaborate sets had others for additional filtering and for stabilising oscillator and screen supplies. Cathode bias for audio valves was avoided by many designers — in many instances, I suspect, because of the poor reliability of early low voltage electrolytic capacitors. This is no longer a problem, as with the large range of low voltage electrolytics now available, suitable replacements for sets that do use them are cheap and readily obtainable.

High voltage medium capacity electrolytics are a different story. They are becoming harder to find, especially in the range 8 - 20uF which was commonly used in older valve receivers. The reason for this is limited demand, but some manufacturers will make a special run if sufficient numbers are ordered.

Recently, one enterprising New Zealand vintage radio group was quoted a very competitive unit price for a special run of 10uF 450 volt capacitors from a Japanese manufacturer. Although the minimum order required appeared at first to be large, the attractive price encouraged plenty of sizable individual purchases and the venture proved to be quite viable. Incidently, this same group, in a similar manner, managed to organise a supply of the old style textile covered hookup wire.

Paper replacements

Paper dielectric capacitors are the most commonly found variety in vintage sets, and their condition today varies considerably. The chief problem is leakage, and this can be attributable to the difficulty of sealing against moisture. Insulation resistances, even in identical capacitors from the same chassis may vary considerably. Those with waxed cardboard sleeves are the most likely to have deteriorated, but, as illustrated in Fig.2, capacitors with thin hard wax or composition coatings can develop cracks, with disastrous results.

Leakage is equivalent to a resistor in parallel with the capacitor, and its effect varies with the position in the circuit. In the case of, for example, a bypass across a cathode resistor of a few hundred ohms, an insulation resistance of one megohm is obviously not very significant. But that same capacitor coupling the anode of the audio amplifier to the grid of the output valve, using a grid resistor of a half megohm, would have serious consequences. Similarly, this same leaking capacitor connected to an AGC line could halve the RF control bias.

My own rule is to replace paper capacitors in control grid circuits, or which are bypassing high value resistors, if their leakage is worse (i.e., lower) than 100 megohms.

Paper capacitors have been, as noted previously, largely superseded by plastic dielectric capacitors, and provided that the working voltage of the replacement is adequate, substitution presents no

Fig.3: A modern polyester capacitor can be fitted into the tubular sleeve of an old paper type with room to spare. This provides a practical compromise between originality and using modern components in old receivers.

problems. Just remember that any capacitor connected to the HT line, even through a resistor, may have a high voltage present during warm up and the voltage rating of the replacement should be adequate. If authenticity is not a problem, for general receiver applications, high-K ceramics — provided that their working voltage is adequate — make compact replacements in most paper capacitor applications.

Frequently, tubular capacitors have one end marked with a band. This indicates the lead to the outside foil, which is normally connected to the lowest impedance side of the circuit; for example, earth in the case of bypasses, and the anode in resistance coupled amplifiers.

Repair or renew?

In the case of older equipment, the question arises as to the possibility of restoring paper capacitors or at least, the best method of retaining their original appearance. Most deterioration is from moisture absorption and it is possible in many cases to drive it out.

In a practical exercise, I tested several 60 year old cardboard cased 0.05uF tubular paper capacitors, and none had an insulation resistance better than two megohms. They were then immersed in molten paraffin wax held at 120°C in an electric oven. After about half an hour, when the seething and bubbling had ceased, they were drained and allowed to cool. Finally, the ends of the cases were sealed with wax. Their resistances are now all greater than 200 megohms.

These capacitors are now serviceable, but this process may not always be successful, and of course, it's no good for composition or hard wax coatings. How long they will remain in good order will be very dependent on their environment. Given similar conditions and effective sealing, their life expectancy could possibly be as good as it was when they were new, and for some restorers this may be sufficient.

A compromise is to insert a modern capacitor in the original casing. This is generally quite easy, Fig.3 giving an idea of the relative sizes. If the old capacitor is first immersed in hot wax, the contents can be readily pulled out of the sleeve. Replacement plastic capacitors can also be fitted into the metal boxes used in the very early receivers, and of course, smaller value capacitors can be connected in parallel to make up high capacitance units.

Mica replacements

The remaining type of capacitor found in vintage radios is the mica dielectric. Mica capacitors are generally reliable and rarely develop leakage. Nevertheless, they can have some problems. A serious tendency mentioned previously is for silvered mica capacitors, when connected across a high potential, to develop a short circuit from metallic bridges growing through the mica.

An often unsuspected, but annoying fault in mica capacitors can be an intermittent open circuit when some of the electrode foils do not make proper contact with the terminal leads. This fault can be especially frustrating in the fixed tuning capacitors for permeability tuned IF transformers.

Like the paper capacitor, mica capacitors are now practically unprocurable. However in most cases, polystyrene and low-K ceramics, provided that they have an adequate working voltage, can be used as satisfactory replacements. ❖

NEW KITS FOR EA PROJECTS

We have received the following information from Jaycar Electronics regarding their release of kits for recent *Electronics Australia* construction projects:

Playmaster Pro Series 3 Amplifier (February/March 1994): The Jaycar kit is complete, with case and all components as described in the articles. All lower-value capacitors are MKT, and all low power resistors 1% high stability metal film. The kit carries the catalog number KA-1760 and is priced at $599.00.

EGO Tester (February 1994): The Jaycar kit is of the 'short form' type, consisting of the printed circuit board, all electronic components, PCB pins and other minor hardware items (but no case). With the catalog number KA-1758, the kit is priced at $19.95.

MIDI Breakout Box (February 1994): This Jaycar kit is again of the 'short form' type, with the PCB and all minor components, but no case. Priced at $13.95, the kit carries the catalog number KA-1756.

Hi-Res Mod for the 1GHz Counter (March 1994): This Jaycar kit is also of the 'short form' type, with the PCB's, all electronic components, connectors etc., ready to be installed in the original counter case as described in the article. It carries the catalog number KA-1757 and is priced at $19.95.

NOTE: This information is published in good faith, from information supplied by the firm or firms concerned and as a service to readers. Electronics Australia cannot accept responsibility for errors or omissions.

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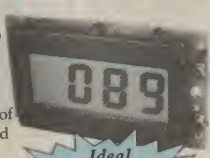

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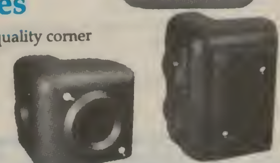

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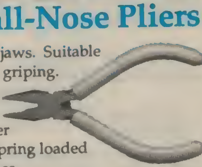

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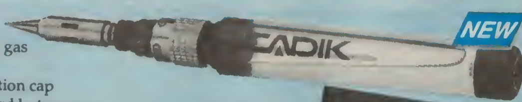

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Max Input Power:...............100w
Impedance:..........................8 Ohm
Frequency Response: fo-20kHz

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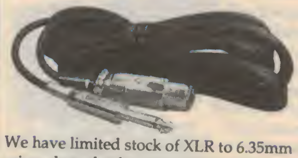

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ALTRONIC COMPONENTS

with MAJOR AL YOUNGER (USAR, Ret.)

The 'Electrajet' ECM diagnostic system

The topic of my December column, 'Getting your car to tell you what's wrong', generated stacks of mail. One company read the article, then contacted me to advise that they had the machine described in the article — designed and made in Australia! A proud owner of the machine also took the time to write and tell me how good it is. So here's a look at Electra International's 'Electrajet' ECM diagnostic system.

You might recall from the December column that my idea was to interface with ECMs which do not have a 'data stream' facility. Electrajet's designers have chosen to interface with *all* ECMs, by connecting it between the ECM and the vehicle's wiring harness (Fig.1). A standard unit has inputs for 64 channels, with a 128-channel system as an option.

The Electrajet also makes a great training aid, as it contains descriptive data on every vehicle system, also data on sensors and actuators — how they work, what they do, etc.

Based on an industrial-grade 386 computer, the Electrajet is operated by a simple set of control keys (Fig.2) and may be battery operated. It's test procedures are all based on the concept of measuring signals being sent to and from the electronic control module (ECM) in a vehicle. Tests can be on individual components, with the results displayed on the screen and then printed out.

The screen presentation is very simple, yet very effective and easy to understand. If the measurement is spot-on, the display's in *white*; if it's low, the display turns *blue*, while *red* means it's too high.

Built-in database

The steps in efficient fault diagnostics are *measure*, *display* and *analysis* — that just about says it all. But how do you do the 'analysis' bit? Well, the Electrajet has in its database data on what all the signals are supposed to be, as referenced signals, voltages and ohms.

No, you don't need a book. If you want to know how a system or a sensor works, you press 'HELP'. If you want the pin-outs or location, you select 'TESTS'. To monitor a waveform you select 'SCOPE', and to monitor operating data you press 'STATUS'. No more books draped over the fenders! It does this for any automobile application where a microprocessor's used, whether for engine management, anti-lock braking system (ABS), electronic transmissions, electronic suspension, climate control system, etc.

A real boon

That ability of Electrajet to show the location of a module or component is an extremely handy feature. I understand that 'location' books are available by manufacturer and type of vehicle, in Australia, but it's just more money to spend gathering information to enable the autotech to fix the car. Of course you may purchase all the factory manuals, which will put you in the poorhouse...

The Electrajet as mounted on a trolley for the service shop. A full keyboard and printer are in pull-out drawers under the control console.

But the Electrajet provides the *location* of all ECM-related components. Trying to locate the ECM? It's there (a video picture) when you turn the Electrajet ON. Another handy item is info on the locations of fuses, fuse links and relays. A nice feature to keep you out of a book!

Testing features

Tests can be made with the Electrajet in any of four ways:

1. You can monitor the whole system as it operates under test conditions and see a display of a series of measured values.
2. You can choose to measure or graph any one (or more) of the signals or quantities being either received by, or sent out from the ECM.
3. You can select a particular circuit between the ECM and the wiring harness for testing. If that circuit should be carrying a steady or slowly varying voltage, or a pulse, or have some device of a particular resistance connected to it, the Electrajet can be called up, by a single command from the control panel, to test that circuit.
4. You can make 'hands-on' measurements using the *probes* provided by the Electrajet, by directly connecting them to a component.

By fitting a fuel pressure sensor to the vehicle, extra tests become available. What kind of tests? Well, say we are trying to diagnose an EFI (electronic fuel injected) vehicle; by monitoring the fuel pressure we can make sure it's cor-

rect under all conditions. This will allow for additional tests to be made, related to fuel pressure — such as leaky injectors.

To aid in diagnosis, the Electrajet provides some standard test sequences. Harness problems are common, for example, so various 'harness' tests are provided. The tests will measure volts or ohms on any suspect harness. 'Status' checks are also provided, especially 'Key-on/Key-off' checks. You may also generate your own particular sequence of tests, and save them in memory for later use.

Demonstration

In a demonstration I was given, the Electrajet was hooked up to a brand new Ford Falcon. The ECM was pulled out and placed in the Electrajet's socket. Leads were connected to the car's battery, and a fuel pressure sensor was placed in the fuel line. (If you don't know where to tap the fuel line or where the ECM's located, the Electrajet shows you a picture. Can't get much easier than that, can you?)

The first test was actually Key-Off, since the Electrajet checks all the ECM pins as soon as its turned on. The battery and earth connections appeared in white, with all other readings in blue (i.e., 'too low'!). The ignition was then turned on. Some readings changed from blue to white, such as battery switched voltages.

The cold engine was now started. Soon more readings in blue (low) were changing to white (normal). The coolant temperature sensor remained in blue (below normal), until normal operating temperature was reached, when the reading turned white.

For a moment, the bloke demonstrating the machine programmed in a 'high' condition, to show how the colour would change to red — which it did.

The demo also gave me a good look at the Electrajet's Scope function, a very nice feature. This is a fully featured and scalable four-channel storage oscilloscope, with two display screens: one for the waveform being tested and the other a stored reference waveform for comparison. So you know what you're looking for, without have to go to a book.

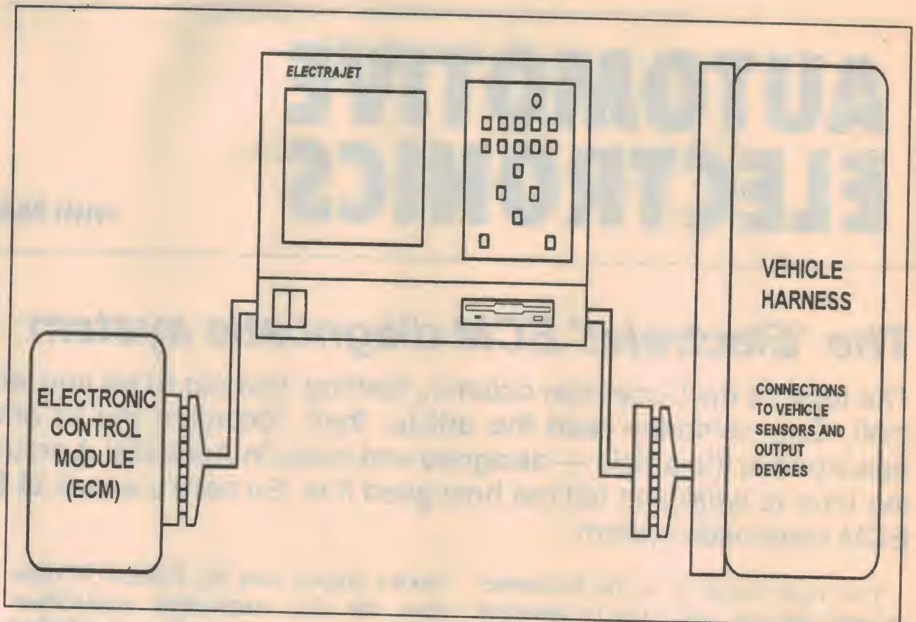


Fig.1: How the Electrajet is connected between the ECM and the harness in the vehicle. A very straightforward approach...

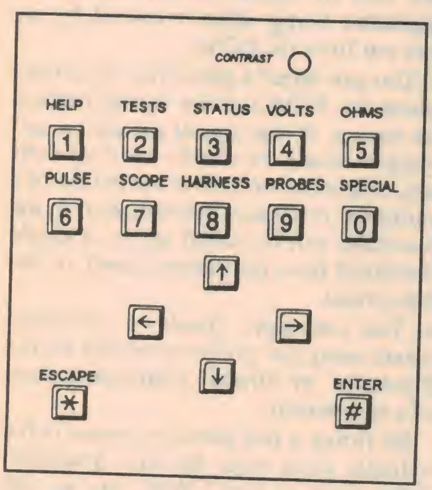


Fig.2: All of the Electrajet's functions can be controlled with this very easy to use keypad.

How it stacks up

So, let's see how close the Electrajet comes to covering what I listed in the December column as the things such a machine should do. Remember though, these requirements were for vehicles with 'data stream'. Most automotive systems do not have this feature.

Here's the list again, showing how the Electrajet rates:

1. Display hook-up and procedure instructions. ✔
2. Read and display code. ✘
3. Interpret codes. ✘
4. Read and display the ECM data stream. (Display only) ✔
5. Provide diagnostic data to fix the fault. ✔
6. Store all data. (only tests and waveforms) ✔
7. Provide a technical database (schematics, connector pinouts, etc.). ✔

For autotechs who have 'given up' on fault codes, then, this machine just about does it all. It doesn't *read* the data stream, but this is just a software function, and at present is not the top priority. At present, facilities for storing data are limited to tests and waveforms.

At present the list of cars it hooks up to covers six pages, so I'll just list the systems:

Bosch L-Jetronics (35 pin)
Bosch Le-Jetronics (25 pin)
Diesel D-Dec (76 pin)
Ford EEC-IV (60 pin)
Ford/Mazda (64 pin)
Ford/Mazda/Toyota (52 pin)
Ford/Mazda/Toyota (42 pin)
GM/Holden (56 pin)
GM/Holden VR (56 pin)
Honda/Rover (53 pin)
Mitsubishi (30 pin)
Mitsubishi (37 pin)
Mitsubishi (53 pin)
Nissan ECCS-3 (51 pin)
Nippondenso (42 pin)
Nippondenso (52 pin)

This represents about 150 different cars, and the same amount of software is required. Actually more, because the software's different depending on transmission and whether the car is fitted with an air conditioner. Almost all the cars built in Australia are covered, back to 1982. (This is a good example of the way the whole automotive world has to go to work, when 'Detroit' changes pins or systems...)

Your own data

The real answer, of course, is to measure your own software data from a new model car, so you can use it as the reference for future tests. This is currently not a standard feature of the

Electrajet, but it can be done with additional knowledge, furnished by the Electrajet people.

Most diagnostic systems like the Electrajet are missing information on sub-systems that are *not* under the control of the ECM, but can still adversely affect ECM operation. The two main culprits in this respect have been known to drive many an autotech to Dover Heights: the EGR (evaporative gas recirculation) sub-system and the emission control system. On many vehicles, these systems are vacuum and/or temperature controlled. Information on these systems, especially vacuum diagrams, are a necessity.

Electrajet doesn't provide this information at present, but it could easily be added in the software.

Overall evaluation

The Electrajet is more than a test machine; it's also an excellent training device. This feature may not be appreciated by all, especially when you first see it in operation.

As well as serving the basic purpose of reading the data on all the ECM inputs and outputs, the Electrajet goes further than most in giving an indication of whether each line is *normal*, *too low* or

Electrajet even provides on-screen pics showing parts location...

too high. Most machines just give readouts, with no evaluation (diagnostics) — that's left to you.

It also provides a database with pinouts, circuit schematics, voltages, waveforms and resistance. Yes, that's correct, you do not need a book to look up the readings and what they mean.

In short, if you can't fix a car with this machine, you should think about changing your occupation.

What about the cost? That's the big question, of course. Starting from January 1994, the Electrajet has been marketed as a basic package with optional 'software and wire harness' kits for a variety of vehicles. So the cost will depend upon the types of vehicles one wishes to work on. An RS-232C serial port for data communications is also an option.

As well as giving a rundown on the Electrajet, I hope this review will answer many of the questions received following the December column. As you can see, reading the voltages or whatever, on all the ECM pin-outs, just gathers data. Additional information is required in order to interpret the data, diagnose and fix a faulty vehicle; the raw data is just the starting point.

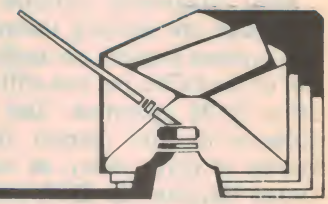
If you want to get more information on the Electrajet, just call a guy called Walt at Electra International, on (07) 812 0651 or (018) 759 610.

Correction

Finally, a small correction. In my January column, describing a low-cost oxygen sensor tester you can build, a small error crept into the schematic diagram on page 122. Resistor R1, from the input to ground, should have a value of 10M (megohms), not 10k (kilohms) as shown. The tester will still work with 10k, but for correct readings you need a 10M resistor because an oxygen sensor has a very high internal resistance, and its output voltage drops if it's loaded. ❖

Information centre

Conducted by Peter Phillips



Matters electrical and electronic

This month there's discussion on switch ratings for DC and also leakage current in an electrical installation. In addition I have some interesting (and bizarre) project ideas, and our usual range of comments and information about projects.

I'm always pleased when I get letters from electricians. I suppose it's because I spent my formative years as an electrician in a large factory, before moving into electronics. I've probably said this before, but today's electrician can't really avoid electronics. But on the other hand, today's electronics technician can't avoid electrics, either.

For example, how do you classify a light dimmer? I'm sure there are just as many electricians who repair light dimmers as there are electronic types who install them. Another electronic device which might appear 'electrical only' is the residual current device (RCD). Known by the public as safety switches, these devices are usually electronically operated.

But perhaps the simplest device of all, with equal importance in both electronics and electrics is the light switch. Other devices include relays, the various components of an alarm system, 12V fluorescent emergency lighting, and so on.

So I think it's appropriate for us to now and again include matters electrical in *EA*. Our first two letters this month fall into this category, starting with a question about leakage current.

RCD query

I'm an electrical tradesman and my son is an electrical contractor. We are wondering if EA has developed a device for testing installations to record the amount of leakage current for inductive appliances and devices, before installing a residual current device (RCD).

It appears RCDs are being installed in quite a few homes these days. However the nuisance trips caused by refrigerators, low-voltage desk lamps, air conditioners, tumbler dryers, welders and many other inductive devices are causing contractors to not install these devices correctly.

It seems to us that when an RCD is installed, two power circuits are needed, one for inductive loads and the other for non-inductive loads. This is obviously more costly for the consumer.

We would be grateful for the details of any suitable leakage current testing device you might have developed. (A.D., Highett, Vic).

Having been out of the electrical field for some time, I sought advice from a colleague who is well versed in the problems of electrical installations. My first question to him concerned whether inductive appliances in particular have leakage current problems. I couldn't see why this should be so, and my colleague agreed. In fact we both concluded that heating elements are the most likely cause of leakage current.

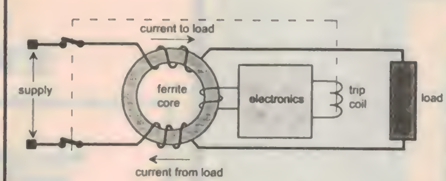


Fig.1

So, A.D., I'm not sure why you are blaming inductive loads and suggesting special circuits for these appliances. However, there is no doubt that some appliances are more prone to tripping an RCD than others.

For those readers who are wondering how these devices work, I've included a diagram (in Fig.1) which shows the basic operation. The idea is that the current in both the active and neutral conductors should be the same. If this current is different by 30mA or so, the electronics will operate a trip coil, isolating the circuit from the supply.

Most RCDs respond in around 0.03 seconds (30ms). The only reason an RCD trips is because of an imbalance in the currents in the active and neutral conductors, caused by a leakage current to earth.

If we assume a minimum trip current of 30mA, and a supply voltage of 240V, there needs to be a resistance to earth of 8k ohms or less. All electrical installations should have a minimum resistance to earth of 1M ohm when measured with a 500V DC insulation resistance tester, and individual appliances should be the same. An exception is the leakage resistance of a heating element, which must exceed 10k.

However, what about the effects of capacitance? The SAA wiring rules say that *the current which may pass to the installation earthing system from all the radio interference suppression devices connected to the installation shall not exceed 10mA*. I assume this should also include leakage current via stray capacitance. In other words, the current due to capacitance as measured in the earthing conductor. However, I wonder about the 90° phase shift, and how one actually measures this current as distinct from leakage current due to resistance.

A leakage current of 10mA via capacitance equates to a total capacitance to earth of 0.13uF, which is quite likely to be found in a single light dimmer. So my point is that rather than inductance, I'd be blaming capacitance or resistance for false tripping of an RCD.

So what's the answer? Measuring leakage current with an ammeter seems

the obvious way, but it's often awkward to break into the earth conductor. However I'm told Clipsal is now marketing a clamp-type ammeter with a milliamp range. There's also bound to be others on the market. Simply clip the ammeter over the main earth conductor to get a measurement. If it exceeds 10mA and the insulation resistance of each appliance and if the wiring checks out correctly, go looking for capacitors connected from active to earth.

While you most likely already have one, we described an insulation resistance tester in July 1993. We haven't described a project designed to measure leakage current, or perhaps more appropriately, a project that measures the *difference* between the current in the active and neutral conductors of a power or lighting circuit.

I'm sure there must be other ways of going about this, and I'd be interested to hear from other readers who may have solved the problem.

Switch rating

The What?? question in May 1993 asked for a simple way to convert existing wiring so two lights could be operated independently, with one on a two-way circuit. The solution (given in June 1993) was to use a full wave rectifier to convert the 240V mains to DC, along with two diodes to block or pass current depending on the position of the switches.

Being an unconventional circuit, quite a few readers protested about its safety and legality. A common criticism was that the switch rating would be insufficient. Most light switches, like the Clipsal 30MI are rated at AC only, usually 10A at 240V.

One of those who felt the circuit was unsafe has since sent me details of the DC rating of a Clipsal 30M switch. This switch is a single pole version of the 30MI (which was the switch specified in the circuit), so there's likely to be a difference between their ratings. However it's interesting to have this information. Here's what our contributor has to say about switching DC:

I followed up the question of switch ratings with Gerard Industries (Clipsal) and spoke to someone in their R&D department. He kindly sent me details of the AC and DC rating of their 30M switch and made the point he wouldn't be 'silly' enough to use this switch for any application over 32V DC.

During my apprenticeship I was involved in maintaining a very old building in Adelaide. This place had both DC and outer and neutral fuses. How many old timers know what the OUTER means? (I confess I don't — P.P.) *I once replaced a switch on the DC line with an AC-only switch and was rewarded with a face covered in carbon at switch on. The only load on the line was a desk lamp. Materials in modern switches may have improved, but getting back to the point: AC and DC don't mix.* (J.S., Middleton, SA).

I can't (for copyright reasons) reproduce the graph showing how the 30M switch performed on DC, but I can give you the results. The test was conducted for 12,000 complete on/off cycles in accordance with AS3133-1983, at 10 cycles per minute with an ON time of three seconds. The load was non-inductive and the 12,000 operations were evenly distributed over the two ways of the switch. At the completion of the test, the test switches were still capable of normal operation.

The results are given in Table 1. Notice how the load current falls significantly for voltages above 100V DC.

Table 1: 30M switch rating

voltage (DC)	current (amps)
240	0.42
200	0.51
160	0.63
120	0.8
100	1
80	2.1
60	5
40	10

The full 10A rating is achieved at 40V. The current rating at 240V DC is quite low at around 0.4A, but this still gives a total lamp power of around 100W.

But are the results of Table 1 for pure DC or pulsed DC? The documentation doesn't say, but I would think pure DC. In the circuit, the DC to the lamps is unfiltered, so you can think of the waveform as a sinewave with the bottom half reversed to the top. Our next correspondent thinks this is significant...

I don't agree that the switches for the solution to the May 1993 What?? question need to be derated. As I understand it, the problem with DC is arcing as the switch opens. AC doesn't tend to draw out arcs since the current passes through zero after each half cycle.

In this case, the circuit doesn't use pure DC, but rectified AC, and the current still falls to zero (or nearly so) after each half cycle. (G.L., Ringwood, Vic).

I agree with you G.L., so I'm standing by my original opinion that the circuit given as the solution to the problem is both legal and operationally sound. However, it's good to have some data on switch derating for pure DC.

Solar powered fax

Getting back to electronics, our next correspondent wants information about powering a 24V fax machine from a 12V solar powered supply.

I want to operate a 24V fax machine from a 12V solar powered supply. I haven't seen a circuit that acts as a step-up supply except the 1.5V to 9V converter of May 1990. Is it possible to change the ratio of the transformer in this project to make it suit my application? By my calculations, the ratios should be 48 turns for the primary, 4 turns for the feedback and 96 turns for the secondary winding.

Another idea I had was to connect two 12V gel cells in series and to use these to operate the fax. The converter would supply the charging voltage to these batteries, and operate continuously to supply a trickle charge for the gel cells via a series adjustable regulator. Is this idea practical or is there a more obvious solution? (D.H., Beechwood, NSW).

The best way to go about this, as you say D.H., is to connect two 12V gel cells in series and to charge these via a converter powered by a solar cell array. However, the 1.5V to 9V converter is not really suitable as its output current at 24V would probably be too low. Incidentally, there is no need to change the primary or feedback turns, simply add more turns to the secondary. An alternative converter is one described in February 1992. This project was designed to charge a 12V gel cell from a 6V solar cell panel, and I can see no reason why it couldn't work with a 12V input to give a 24V output. The circuit doesn't use a transformer and uses a diode pump arrangement to get the higher output voltage.

If you decide to use this circuit, please note the following mistakes in the article. The circuit diagram should show R1 as a 180k (not 180 ohms) and R2 should be 22 ohms, not 220 ohms. This resistor is not shown on the layout diagram and fits between C2 and IC1.

Earth loop

Simple projects can often cause the most perplexing problems, as the next letter illustrates.

My congratulations for an excellent magazine and thanks for the many projects I have been able to construct over the years.

The Multimedia project in the January 1993 issue is the first mains powered audio project I've built and

it worked first off. However, there's a slight hum which I assume to be an earth loop. Any attempts to alter the screening gives a louder, more strident buzz.

I've built two amplifiers into an aluminium box that also houses a transformer. Three inputs and a rotary selector have been added with all screens commoned at the input end only, then connected to a common chassis earth point with the link from R15.

Would you please advise me of any other measures to cure the hum in this otherwise brilliant project. (A.G., Kingsgrove, NSW).

Earth loops are always a problem. My first suggestion is to isolate the unit from the mains earth, perhaps with a double adaptor with the earth pin removed. If this cures the problem, then obviously the loop is through the mains earth. If not, keep removing earths (the shields) until the hum is minimised.

If the problem is due to the mains earth, you might be tempted to leave it unearthed. For safety reasons you shouldn't do this, so I suggest you mount the transformer so it's not in contact with the aluminium chassis. You can then earth the transformer separately with the mains earth. The aluminium box is now earthed through the shielding, via the earth connection of the computer. Just make sure the braiding around the cables is solid and well connected.

Another problem could be power supply hum. I assume you're running both amplifiers from the same power supply. If so, this is twice the load the supply is intended for, possibly giving enough ripple to cause audible hum.

To reduce the hum, you need to decouple the amplifiers by supplying each one via a decoupling circuit, shown in Fig.2. Here a low value resistor (1 ohm or so) connects between the output of the rectifier and the load. A 2200uF filter capacitor connects across the load.

Project ideas

When it comes to imagination, you've got to hand it to the next contributor. He's got a few project ideas, some practical and quite possible without much work, and others that... well...

I thought I might suggest a few ideas for projects:

1. *An audible low fuel warning device for cars.*
2. *A rectifier-regulator circuit so a battery can be charged from a pushbike dynamo, letting you have lights on when you've stopped.*
3. *A whistle or UHF remote operated headlight switch so you can find your car in the dark.*
4. *An RF amp for a video sender, for those people like me who live in a house with such thick walls the signal can't even be picked up in the next room.*
5. *An old-fashioned LED watch.*
6. *An adaptor cable so you can plug a cable from the earphone socket of a TV (or radio) into the microphone input of a cassette recorder.*
7. *A means of making a domestic door open and close automatically like in a supermarket.*
8. *A repeater for a cordless phone.*
9. *A simple display fitted into a full-face motorcycle helmet, which shows basic engine status.*
10. *Some sort of non-microwave radar for hobbyists.*
11. *A V8 engine sound simulator for owners of four cylinder cars.*
12. *A voice changer fitted into an FM wireless mike.*

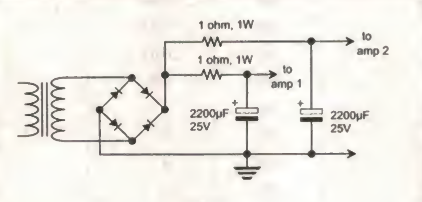


Fig.2

13. *A UFO detector that operates a camera and then transmits a tone on FM.*
14. *A PIR detector that triggers a camera so you could give police a photo of the burglar.*
15. *A universal UHF remote control system that operates a solenoid arranged to push against buttons on a TV, camera or VCR.*
16. *A UHF remote controller to switch appliances like a TV, fan, air-conditioner.*
17. *A means of freezing a TV picture, perhaps when there's a good tackle on the footy.*
18. *If it's possible, a project to cause an image on a TV screen to be enlarged.* (D.O., Nambour, Qld).

There's some interesting ideas here, D.O. I've not included all the ideas you sent in as space is limited. A low fuel warning device is difficult because of the many different types of petrol gauges. Charging a battery from a pushbike dynamo is quite feasible, and would be a simple project — one we'll look into.

A remote-controlled headlight switch is already available using the single-channel UHF remote controller described in April 1989, though we haven't produced one that responds to a whistle. A video transmitter with grunt is quite practical, but likely to infringe the broadcasting restrictions as the stronger signal would possibly be picked up by the whole neighbourhood.

I remember seeing a LED watch many years ago. The main problem was you needed both hands to see the time, the one attached to the wrist holding the watch and the other to press a button. I thought it was the stupidest thing I'd ever seen! It would also be fairly expensive, so it's unlikely, D.O.

A patch cord from an earphone socket to a microphone input on a tape recorder is really very simple, as all you need is a resistive attenuator. Not really project material, unlike idea 7 (the automatic door opener) which is starting to get quite complex. The problem is the mechanics, not the electronics. We've already described various detector devices (ultrasonic, PIR) which could trigger such a door.

An FM phone repeater might also get the Spectrum Management Authority a bit testy, although in principle it's simple enough. An engine status indicator for a face helmet has potential. Low frequency radar would be tricky (like any radar), although we're planning a project that uses an ultrasonic transmission to sense objects a preset distance away. A sort of radar!

While I've never seen one, I believe there's a commercial product for idea 11 that makes great revving sounds through the car radio, but linked to the speed of the car. For idea 12, we described an FM microphone in June 1989, and a bit of signal processing at the front end would probably mess up the voice.

A UFO detector(!) has a few practical problems. Triggering a camera from a PIR detector is certainly possible, but I wonder about the effect of a flash. Any self-respecting burglar would probably take the camera along with the house jewels!

Ideas 15 and 16 are quite possible, using either the 12-channel UHF remote system presented in March 1993 or with the 4-channel system soon to be described.

While technically possible, freezing or expanding a TV picture direct off air would be difficult and costly. Each frame of the picture would need to be

converted to digital, then captured in digital memory, so it could then be frozen or enlarged. It's perfectly feasible, just a bit complicated and expensive. Not as silly as it sounds!

Pro Series 1

Now back to projects of the past. Here's a letter that will interest constructors of our popular Pro Series 1 power amplifier, described in 1990.

I have just finished putting together the Pro Series 1 power amp and the Pro Series 2 pre-amp with very successful results. The sound is great, thank you.

Unfortunately, I am finding that the overload-error LEDs are coming on at a volume level of about one third full volume. I tried removing the 330pF capacitors from under the PCB, but to no avail.

Can you please help me solve this problem, as I am only 15 years old, and have constructed many of EA's projects. Thanks to my father on the financial side, I hope I will go on to do electronics full time later on. (W.S., Kogarah, NSW).

While unusual, we have found that given the right mix of components, it's possible for the Pro Series 1 amplifier to oscillate. When this happens, the overload-error LEDs light, indicating a difference between the input and output signals. Because the oscillation is above the audio range, you don't hear it.

The 330pF capacitors were added to stop this instability, but W.S., it seems you have one of those with the right mix of components. This problem is fully addressed in the January 1994 issue, in an article called 'New MOSFETS for Audio Power Amplifiers'. Here, the designer Rob Evans describes various things about the Pro Series 1, including curing instability problems.

The article is too long to include here, but as it seems you are a regular reader W.S., it's likely by the time you've read this in March, you will have already solved the problem. We all wish you well in an electronics career, you seem cut out for it.

Teletext-computer software

In June 1993, we described how to interface the Dick Smith Teletext decoder to a computer. We also gave the address of the designer of the interface, so you could purchase the necessary software. Since then the designer, Mark van der Eynden has moved. He has written to give us his new address, with a couple of comments that might interest owners of TV sets fitted with Teletext.

Many people are asking whether they can adapt the Teletext decoder in their VCR or TV, so it works with the interface described in June '93. In many cases the answer is yes.

It will work with decoders that use the 5231 and 5243 ICs, as these are simply enhanced versions of the 5230 and 5240 ICs. The 5231 (used in the DSE decoder) has a higher noise immunity and the 5243 supports some of the more unusual foreign characters. Providing the VCR or TV set doesn't have a live chassis, there should be no problems interfacing the decoder to a PC.

My new address for those who want the software to drive the interface is PO Box 467, Mt Waverley, Vic 3149.

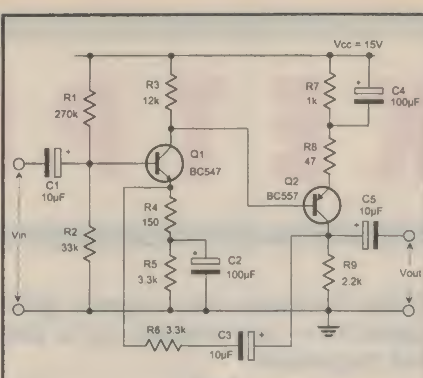


Fig.3

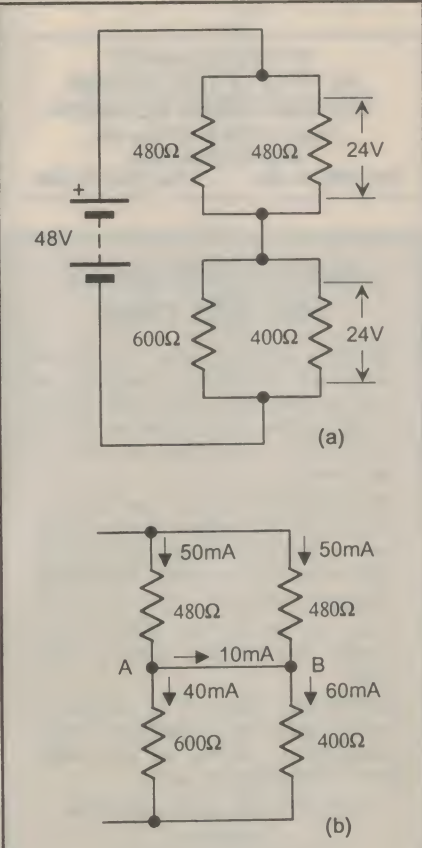


Fig.4

The cost of the software is $10 for the demonstration files and read.me files and $25 for the complete software package.

Mark has also advised me that nearly half those who purchased his software had interfaced to their PC a Teletext decoder other than the DSE decoder. In case this inspires you, the only errata in the article is the pin numbering of the connection diagram in Fig.2 of the article. Pins 8 to 14 should be numbered the other way round, with pin 14 at the top right of the diagram.

What??

This month we're asking two questions, in case you find the first one too simple. The questions are about the transistor amplifier shown in Fig.3. Firstly, what is the approximate voltage gain of the circuit? When you've figured that one out, give a reason you can't connect R6 to the output terminal of the amplifier and do away with C3.

Answer to February What?

The answer is 10mA. When an ammeter is connected between points A and B, it effectively shorts these points, giving the equivalent circuit of Fig.4(a). The voltage drop across each section is 24V, or half the supply voltage, as the equivalent resistance of each parallel pair of resistors is 240 ohms.

The current in each resistor can now be found with Ohm's law, giving the values shown in Fig.4(b). By Kirchhoff's current law, the current in the ammeter is 10mA. ❖

NOTES AND ERRATA

Improved Decoder for ACS signals - 3 (December 1993):
The Realistic 12-625A AM/FM portable mono radio into which the decoder module is fitted is no longer available. Tandy has advised us that its replacement model, the Realistic 12-639, is completely compatible with the superceded model, and can be used instead.

Information Centre (September 1993): In the 'Bio-feedback' section, reference was made to an *ETI EEG* construction project in September and November 1987. This project doesn't seem to exist! The bio-feedback *ETI* references which should have been listed are: a construction project, 'Galvanic skin response meter' (March 1977); theory and project, 'Electromyogram' (September and October 1979); and an article on 'Bio-feedback' (October 1989).

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Remote controlled Light Dimmer - 1

Continued from page 85

in Fig.1. The oscillator section is around Q1 and its operating frequency is set to 304MHz with C6. The oscillator is keyed on and off by the output (pin 17) of IC1. This output is a digital code, determined by the binary input from SW1 to SW4.

Power is applied to the transmitter circuit via diodes D1 to D4, when one of the pushbuttons is pressed. This lights the LED indicator and causes IC1 to output a different binary code for each pushbutton.

Returning now to the main schematic, the UHF receiver section is a prebuilt, prealigned module. This module contains a bandpass filter, an RF preamplifier, a regenerative detector and an amplifier and produces the transmitted binary code at its output.

This signal is applied to the decoder IC11, which produces the code originally applied by the pushbuttons to the transmitter encoder IC.

Because only one pushbutton is operated at a time, the four codes are 0001, 0010, 0100 and 1000. When a valid transmission is received by IC11, its VT terminal pin 17 goes high, along with the relevant output (pin 10 to pin 13). For instance, if the auto-down button is pressed on the transmitter, the transmitted code will be the binary number 0001.

When received by IC11, pin 17 and pin 10 will both go high. The only AND gate that can respond is IC12B, and its output goes high, applying a positive pulse to the clock input of IC5B.

Both the encoder and the decoder have 'address pins' that need to be set so both ICs have the same address. These pins can be connected to ground, the supply voltage or left open-circuit. What matters is that both ICs should have the same 'address'. If you are sure no one else in the neighbourhood has a similar transmitter, you can probably leave all the address pins of both ICs open-circuit.

The frequency of the internal clock in both the encoder and the decoder is determined by an external resistor. In the transmitter this is R3 and in the receiver section it's R44. These two resistors should have the same value (or close to it).

In part 2, we will describe how to build, test and use the dimmer.

(*To be continued.*) ❖

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

March 1944

Long range delivery: Extra fuel tanks have been fitted to several American single-seat fighters, which enables them to fly non-stop across the Atlantic. By this plan their delivery is speeded up and the risk of loss through U-boat action avoided.

External fuel tanks which can be dumped, are commonly used for long-distance fighter patrols.

Crewless radio plane: A crewless, radio-controlled plane is stated to be Hitler's latest weapon. The aircraft is filled with explosives and just sufficient fuel for it to reach its target.

Although not yet used in attack, the Germans have erected many take-off points along the west coast. Several of these have already been destroyed by Allied bombers.

March 1969

The world of the atom: Working with a highly advanced electron microscope, scientists have produced images which correspond directly to the planes of atoms in a crystal and the space between them, with greater clarity than ever before.

Within a crystal, these planes of atoms are incredibly close together — only a few Angstroms units, or about ten billionths of an inch, apart. Using an optical microscope, light waves are about a thousand times too long to resolve them. However, under an electron microscope, the scientists were able to magnify the interplanar spacings of germanium and silicon crystals 500,000 times. The image quality was so good that they could be enlarged another 40 times, showing any tiny defects in the crystal lattice as slight variations in the regularity of the spacing between planes.

Image intensifier for night viewing: The latest electronic aids to vision can make visible objects whose illumination is only one ten-thousandth of that required for normal vision.

Unlike earlier image intensifier tubes which used a source of infrared radiation to illuminate the object, the Mullard XX1060 three-stage image intensifier is completely passive. Starlight, or even faint sky glow, will produce sufficient light for a visible display when completely imperceptible to the naked eye.

Fast charging secondary cells: Researchers in the USA are investigating ways of safely recharging sealed nickel-cadmium cells and batteries in one hour or less. Rapid charging is made difficult because of the disastrous consequences of high level overcharging — the heat and gas generated destroy the cell.

Provided that the charging current stops precisely when the cell is fully charged, the whole process may be accomplished in one second, at greater than 90% efficiency, by delivering 50A pulses to 10mAh cells. After 100 cycles of full charge and discharge, the researchers did not find any electrode damage.❖

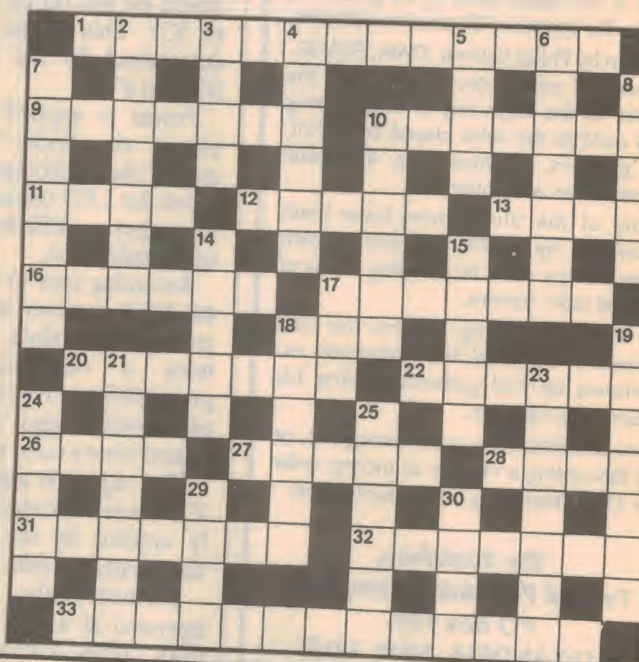
EA CROSSWORD

ACROSS

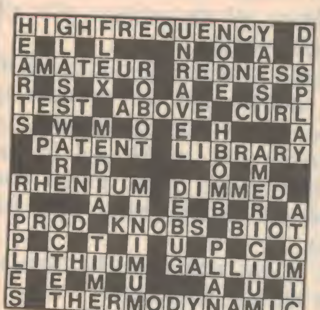
1. An increase in amplitude. (13)
9. Determines layout or pattern. (7)
10. Source of electrical energy. (3,4)
11. Abbreviation of three-sided mathematics. (4)
12. Pastime of an enthusiast. (5)
13. Discarded appliances, etc. (4)
16. Part of an analog meter. (6)
17. Gives attention to auditory stimuli. (7)
18. System of locating position. (1,1,1)
20. Useful rare metal. (7)
22. Structure in a speaker enclosure. (6)
26. Aspect of sound reproduction. (4)
27. Perfect, or of excellent standard. (5)
28. Not closed. (4)
31. Lattices, screens, gratings. (7)
32. Integrated during construction. (5,2)
33. Occurring in a moment of time. (13)

DOWN

2. Symptom of a faulty spark plug. (7)
3. Points of attachment. (4)
4. Melting. (6)
5. Electric train sets, radio-controlled cars, etc. (4)
6. Minimum winding. (3,4)
7. Preparing tape for modified replay. (7)
8. Well-known brand of test equipment. (5)
10. Fragmented remains. (6)
14. Produce a raucous sound. (5)
15. Motive power for trains prior to diesel-electric. (5)
17. Printer's speed unit. (1,1,1)
18. Controls path of missile, etc. (6)
19. An RDF device provides this. (7)
21. Stretching force. (7)
23. Manufacturer of air conditioners. (7)
24. Section of system with successive action. (6)
25. Symbol for wavelength. (6)
29. Determine position on grid. (4)
30. Bring to a better state, or —— tune. (4)



SOLUTION FOR FEBRUARY 1994



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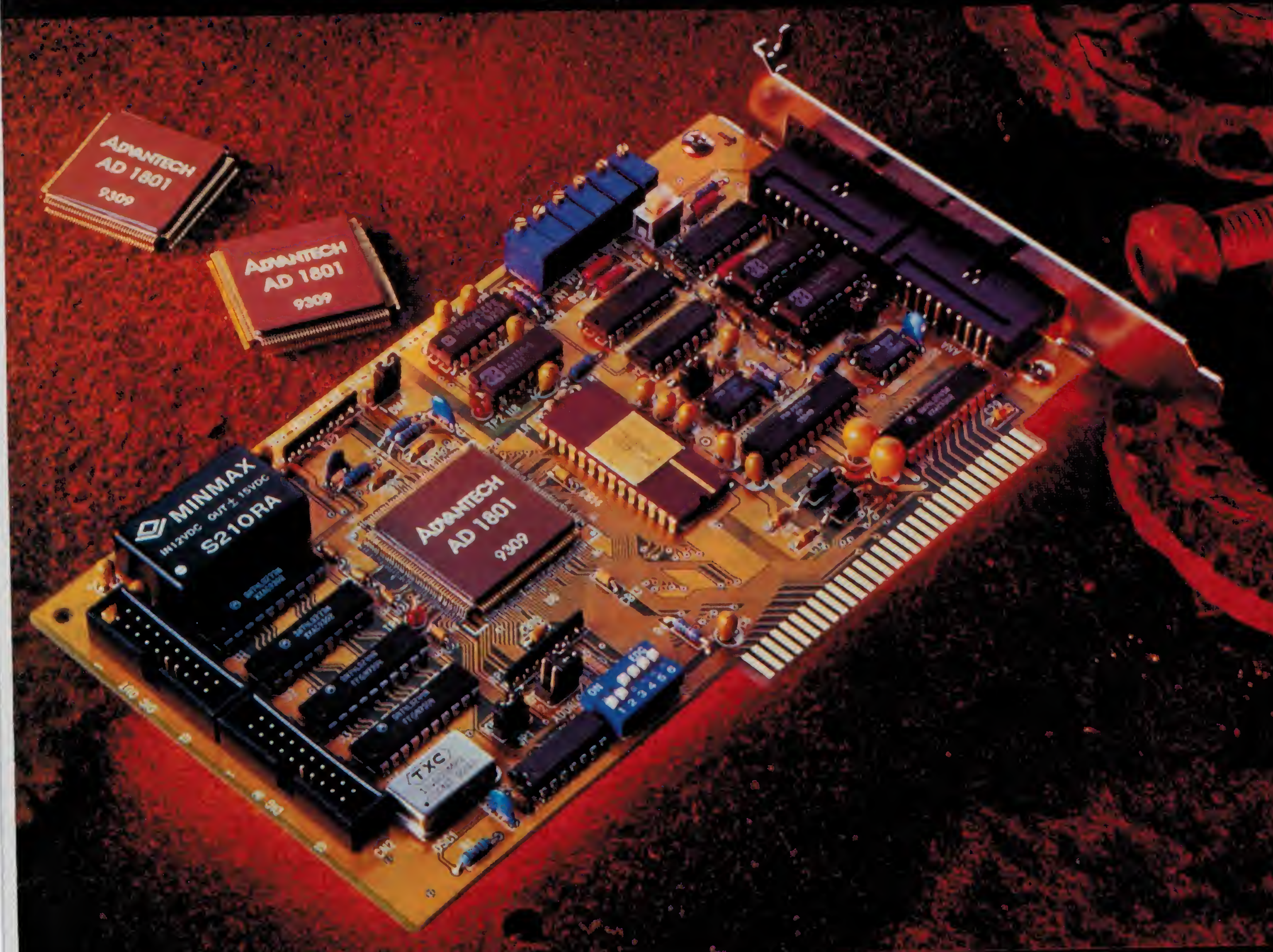
S·U·P·P·L·E·M·E·N·T

TI DEMONSTRATES FIRST ROOM-TEMPERATURE QUANTUM IC WITH RESONANT TUNNELLING

LOW COST DIGITAL NTSC/PAL CONVERTER FOR SATELLITE TV, LASERDISC VIDEO

PC ENHANCEMENT PRODUCTS



ADVANTECH'S NEW HALF-SIZE, HIGH SPEED 12-BIT DATA ACQUISITION SUBSYSTEM CARD — BASED ON A FULLY CUSTOMISED 1-MICRON CMOS ASIC CHIP

NEWS HIGHLIGHTS

TAIT INVESTS $1.5M IN SMD TECHNOLOGY

New Zealand's Tait Electronics, now claimed to be one of the world's largest manufacturers of mobile radio systems, is making further major steps in automating production of its products at its manufacturing plant in Christchurch. It recently installed new automated surface mount technology, in the form of two additional chip placement machines which represent an investment of $1.5 million.

The computer-driven surface mount machines are vital for Tait, as the mobile radio communications market moves towards smaller and smaller products.

The system which Tait settled on is a Yamaha YV112 with a vision system capable of looking at the components through a video camera, digitising and making corrections automatically. The Yamaha was selected mainly because of its placement speed of three components per second. It offers flexibility and the volume production suitable for Tait's commercial manufacturing of radios to suit specific customers, rather than mass-produced products.

"The new system will further improve Tait's international reputation for producing mobile radio products of the highest quality and designed to suit specific customer requirements," said Mr Warren Rickard, General Manager of Tait's Australian subsidiary.

The machine is not only the first of its kind in New Zealand, but the first Yamaha machine to be exported from Japan and operated in the production environment anywhere in the world.

Tait engineers designed a program which allowed all the placement information on their CAD system to link via floppy disk to the PC which runs the Yamaha. This eliminated all physical digitising.

A new soldering oven was installed, using forced air convection to ensure even heating of the boards and reduce the possibility of 'shadowing'. The convection method uses hot air at a temperature of 230°C, on the same principle as a thermowave domestic oven.

To complement the Yamaha YV112, the latest acquisition for the surface mount production area is the Quad 204 IVc, a fourth generation pick and place machine.

For placement accuracy, this machine, selected for its flexibility in handling components, features a closed loop feedback system. The Quad 204 IVc uses a laser for position correction and is currently the only machine in the world with this feature available. Although the Yamaha, with its ability to handle 112 different components, can operate at double the speed of the Quad 204 IVc, (230 - 240 varieties of components) the promise of the new machine is its quick change system. All components can be loaded on to a feeder cart which is locked into the Quad with a foot brake. The simplicity of changing from one cart to another when a different line comes on stream will assist the division's aim.

The addition of the Quad machine brings the total number of placement machines up to six and provides Tait with the most advanced SMD facility in New Zealand. The plant is currently operating three shifts to cope with the increasing world wide demand for Tait products.

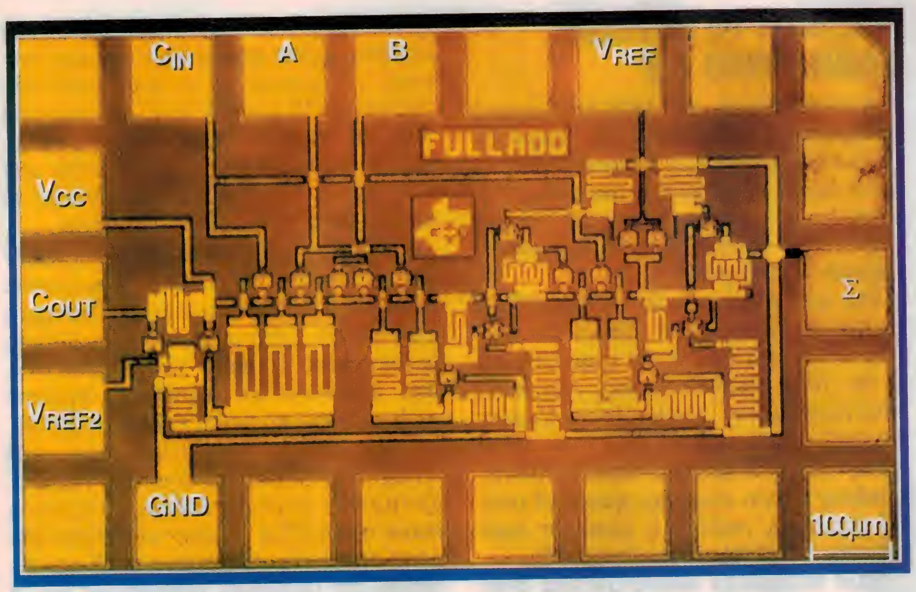
Tait can now build a wide range of products totally under software control, which enables it to switch from product to product in less than a minute. The company employs more than 650 people and has a world wide network of offices, including five in Australia. Its headquarters and manufacturing facilities are in Christchurch. It is owned by its founder, Mr Angus Tait.

TI DEMONSTRATES FIRST QUANTUM IC

Scientists at Texas Instruments have demonstrated the world's first quantum effect integrated circuit that operates at room temperature (24°C).

The circuit, which makes use of a quantum-mechanical effect known as resonant tunnelling, is projected to operate three times faster and have three times the density of conventional integrated circuits. The development was described in a paper given at the International Electron Devices Meeting (IEDM) in Washington, DC.

The logic circuit, a one-bit full adder, incorporates both bipolar and resonant tunnelling transistors. The resonant tunnelling bipolar transistors reside side-by-side with conventional double heterojunction bipolar transistors. This marriage of two technologies — conventional bipolar and resonant tunnelling



— is made possible by a TI developed process.

It allows for more efficient switching operations and more efficient implementation of logic functions. Multiple logic functions can be performed using fewer transistors. The adder consists of 17 transistors — two resonant tunnelling transistors and 15 heterojunction bipolar transistors — replacing as many as 40 conventional transistors fabricated using conventional industry processes.

The resonant tunnelling transistors in the circuit are based on quantum-mechanical effects. The principles of quantum mechanics apply to the behaviour of matter and energy at dimensions of .02 microns and below. At these small sizes, electrons behave as waves and can pass through classically impenetrable barriers.

"Demonstrating resonant tunnelling transistors at room temperatures is a significant breakthrough for the practical utilisation of quantum effect devices," explained Alan Seabaugh, senior member of the technical staff in TI's Central Research Laboratories. "It means that this technology can be applied to portable and desktop computing applications without the need for refrigerants or thermoelectric coolers."

Previous industry demonstrations of quantum devices were limited to operations at -195°C, too cold for broad commercial use.

TI scientists employed resonant tunnelling which permits an electron, under certain conditions, to pass through a classically impenetrable barrier. In this case, the transistors operate by transferring electrons from one layer of the circuit to another under the control of a voltage that is applied to a control terminal, as in a conventional transistor.

However, the design of the quantum switches exploits quantum resonances in the electron motion, so that many 'on' and 'off' switching states can be obtained from a single transistor. This switching characteristic reduces the number of transistors needed, and the number of lengths of wires required to assemble the transistors into an IC.

"These transistors can be built with the same geometries as conventional transistors, yet there is a 3x improvement in speed and density," said Gary Frazier, nanoelectronics manager at TI. "If we can replace three transistors with one, we get essentially one generation free."

The bipolar resonant tunnelling transistors used in the demonstration IC achieved a current gain as high as 100 and an in-resonance to off-resonance current ratio of 70.

They operate at 3V with a logic swing of 1.2 volts. An NpN heterojunction bipolar transistor structure was used with a resonant tunnelling, double barrier heterostructure integrated into its emitter region.

Instead of silicon, the quantum IC is fabricated with compounds of indium, phosphorous, gallium, aluminium and arsenic. A technique called molecular beam epitaxy is used to build the multiple layers of semiconductor materials on the base wafer. Each layer is only a few atoms thick, about 1/10,000 of the thickness of a human hair.

Although quantum effect electronics are normally spoken of in future tense, there are several near-term applications of resonant tunnelling transistors. These include microwave (X-band), analog-to-digital converters, high bandwidth digital video, ultra high speed triggering circuits and high speed logic.

Researchers in TI's Central Research Laboratories have worked with quantum effect devices since 1982, demonstrating the first quantum effect transistor in 1988. Work on the quantum IC has been supported in part by a contract from the Air Force Wright Laboratories, the Advanced Research Projects Agency (ARPA), and the Office of Naval Research.

TI, HITACHI MAKE 64Mb DRAMS

Texas Instruments and Hitachi Ltd, have begun shipping samples of their jointly designed and developed 3.3V 64-megabit dynamic random access memory chip.

The two companies also worked together in developing the 16Mbit DRAM technology and are currently considering joint development of a 256Mb DRAM.

The 0.35 micron feature size of the 64Mbit DRAM is a fraction the size of a human hair, which is 75 microns in width. The smaller the feature size (or gate) of a memory chip, the more information that can be stored. This new chip is capable of storing approximately 2800 typed pages of text.

The two companies used CMOS technology in fabricating the chip. Its memory cells each measure 1.67 square microns and are designed with advanced stacked capacitors. The chip will be available in 0.5" wide packaging. Applications will include workstations, personal computers and other computing-related functions requiring large data storage.

Teamwork on this next generation memory chip has taken place at TI's Miho, Japan, facility and Hitachi's Device Development Center in Ohme, Japan.

NTL, PACE FORM DIGITAL PARTNERSHIP

Britain's TV research organisation NTL, a key player in compression technology, has formed a partnership with Pace Micro Technology Ltd, enabling both companies to work together on digital TV reception equipment. A target of mid-to-late 1994 has been set to have the first units manufactured. NTL will be supplying the video compression technology and Pace the design, manufacturing and worldwide distribution capacity in the domestic market.

The move is strategically important not only for the two British companies, but also for the future of digital television broadcasting. Satellite operators are plan-

ning to introduce direct-to-home digital services in 1995, and their success will depend on a plentiful supply of receiver-decoder units at consumer prices.

NTL is already established as the world's leading exponent in the new technology of video compression, which makes multi-channel digital TV possible. The company has already supplied a number of professional systems for economic distribution of programme signals by broadcast and cable operators. The next step is to introduce the technology to the domestic market.

Pace is Europe's leading manufacturer of the current generation of analog receivers. The company's product range includes consumer receiver-decoders, professional equipment for multi-point distribution and pay-TV products. The alliance with NTL will allow rapid entry into the digital consumer market as the new multi-channel broadcasting formats are introduced.

Together the companies plan to develop a range of digital broadcast receivers conforming to the MPEG-2 digital compression standard which is set to become adopted world wide. New product development will cover the full breadth of Pace products across satellite, cable and terrestrial applications. In addition to the domestic market, Pace has developed contacts for professional and semi-professional products in China, Australia and the Middle East.

The NTL/Pace partnership announcement follows the recent appointment of both companies to the Steering Board of the Digital Video Broadcasting (DVB) project, the new initiative of the European Launch Group aimed at defining a European standard for the future of digital television by satellite, cable and terrestrial methods. As a result of a Memorandum of Understanding signed by 85 major broadcasters, equipment makers, satellite and network operators and governments, all European digital TV standards agreed under the DVB project will be based on the MPEG-2 video and audio compression standard.

NTL's business manager for Advanced Products, Alan Watson, commented: "NTL is very much at the forefront of digital compression and we've done extremely well this year in the professional market. But we're not a volume manufacturer and this agreement will get our technology into the domestic market. That's why we're so pleased to team up with Pace to develop digital versions of their very successful products."

ADI, IBM TO DEVELOP 60GHZ-PLUS ICS

Analog Devices and IBM have signed an agreement to develop radio frequency (RF) and mixed-signal integrated circuits (ICs) based upon IBM's world leading, ultra high vacuum chemical vapour deposition (UHV/CDD) silicon-germanium (SiGe) process.

The agreement calls for ADI and IBM to design, produce and market the new ICs, which will initially be manufactured at the IBM Microelectronics Advanced Semiconductor Technology Center (ASTC) in Hopewell Junction, New York. The new process enables record-breaking silicon transistor speeds of over 60 gigahertz, making it ideal for high volume, affordable radio front ends.

SiGe technology allows 3V and even 1.5V operation, thereby significantly reducing the amount of battery power required for portable communications, and enabling lighter and cheaper wireless systems. The process can be integrated with digital CMOS into BiCMOS, opening the way for single-chip digital telephones. IBM's 8" wafer production facility will also offer a cost advantage compared to the RF industry standard 4" wafers.

According to Richard Siber, Director for the Wireless Communications service at market researcher BIS Strategic Decisions, Norwell, Mass. "This development is truly revolutionary in that it allows for significant systems such as personal digital assistants (PDA), cellular and cordless telephones, and wireless local area networks (WLAN), giving the entire wireless industry a major boost. This process will negate the need for more expensive gallium-arsenide for operating frequencies up to 3GHz, which is exactly where the high volume action is."

DIGITAL CHARACTER GENERATORS FOR ABC-TV

Quantum Pacific have delivered the first instalment of Dynatech Quanta Delta Character Generators to the Australian Broadcasting Corporation for deployment throughout Australia.

Forming part of a national contract for supply to the ABC, the first instalment of nine systems comprised Delta models ES, SE and SX.

Following delivery, Quantum Pacific were engaged in a five week intensive training course for ABC operators and engineering staff. Training was provided at ABC sites in Sydney, Melbourne and Darwin by Keith White, Marketing Manager of Quantum Pacific and Wendy Loiwe of Dynatech's Hong Kong operation.

The Delta family of digital character and image generators from Dynatech Quanta are claimed to bring unprecedented quality and features to a post or broadcast environment. Features of the Quanta Delta range include: 256 levels of transparency, 32-bit frame buffers with 4:4:4:4 internal video processing, dynamic digital compositing, 256 levels of anti-aliasing, internal linear downstream keyer/fader, 0.289 nanosecond resolution and an easily upgradeable system architecture.

The Dynatech Quanta range of professional video systems are represented throughout Australia by Quantum Pacific, on (02) 905 6800.

NEWS BRIEFS

- The 1994 Pan Asia ***Satellite and Cable Television*** conference and exhibition will be held at the Hong Kong Convention and Exhibition Centre from 22-24 March. For more information phone Greg Hitchen in Singapore on (65) 222 8550.
- Following its acquisition by Computer Sciences Corporation (CSC), Computer Sciences of Australia (CSA) has changed its name to ***CSC Australia***.
- ***INC Manufacturing***, an Australian manufacturer and marketer of AS/400, Token Ring and Ethernet connectivity products, has been awarded the AS3902 Quality Assurance Certification. The certification means the adherence to a set of Australian (AS3900) and International (ISO9000) standards, by which a company has total quality management in all facets of its operations.
- The Society of Automotive Engineers is holding a seminar on ***Automotive Electronics*** on Wednesday March 30th at the AIM Centre in St Kilda, Melbourne. For more information contact the Society's Head Office, National Science Centre, 191 Royal Parade, Parkville 3052; phone (03) 347 2220, fax 347 0464. ❖

The SiGe process, invented at the IBM Research Division's Thomas J. Watson Research Center in Yorktown Heights, N.Y., produces transistors with speeds two to three times faster than competing silicon processes. ABI and IBM began discussing the potential of the process for mixed signal and RF applications in April 1992. Their initial efforts resulted in the fabrication of a 1GHz 12-bit digital-to-analog converter (DAC), as reported at the International Electronic Devices Meeting (IEDM) last December.

GROUP TO DEVELOP PC CONFERENCING

Intel Corporation is joining with other computer and communications industry leaders to develop a specification for PC-based personal conferencing. The specification will consist of work done by several companies and is targeted for release in mid 1994.

Joining Intel in the development of the open specification are leading hardware, software and communications companies including: Compaq Computer Corporation, Compression Labs, Inc., Ericsson Business Networks AB, Lotus Development Corporation, Northern Telecom, Novell, PictureTel Corporation, Software Publishing Corporation, WordPerfect Corporation, VTEL, and VideoServer. AT&T's Communications Services Group will be a communications supporter of the specification.

"We're delighted to be joined by this very powerful group of industry leaders. We expect the convergence of the communications and computer industries to produce a gigantic new industry. Personal conferencing is the first example of this convergence and extends PC capability into real-time communications," said Patrick Gelsinger, vice president and general manager of Intel's Personal Conferencing Division.

The new personal conferencing specification will enable collaborative real time, interactive document and video conferencing between PCs. Specifically, the specification will focus on delivering these capabilities within the existing PC environment, at PC price points. The specification will span a variety of communications infrastructures, including analog, switched digital, and computer data networks. As a result, PC users will be able to exchange ideas — and all the information on their PCs — simultaneously across any distance while talking to each other on the phone.

"As the PC evolves into a conferencing communications tool, the need emerges for a cross-industry open specification that allows users to work simultaneously on the same PC-generated documents as well as share audio and video information over telephone lines and on computer networks. Current standards don't allow for this type of integrated PC work in the personal conferencing environment. In addition, they don't support the full range of PC communications infrastructures," said Gelsinger.

'DIGITAL MICROMIRROR' FOR PROJECTION TV

The innovative component at the heart of a new digital projection display developed and demonstrated by Texas Instruments is a digital micromirror device, or DMD, containing more than 300,000 tiny, movable aluminium mirrors and a wealth of electronic logic, memory and control circuitry.

Computer controlled signals cause the DMD's mirrors to move, and the design of the chip makes it possible to control this movement with great precision. As a result, the DMD reflects light creating high quality images that can be projected, printed or displayed. Images produced by the prototype display system today are said to be comparable in quality to those produced by the best projection display systems now available.

The DMD chip is a pixellated, micromechanical spatial light modulator formed monolithically on a silicon substrate using a standard five volt, 0.8 micron CMOS process. The mirror structures are fabricated after the completion of the CMOS process flow that creates the circuits which provide the electrical signals and, ultimately, the electrostatic forces that physically displace the mirrors. The mirror fabrication process is performed using standard CMOS processing equipment and is fully compatible with all earlier process steps.

The chip measures 15 x 12.7mm and is packaged in a 96-pin ceramic package with an anti-reflection coated window. The micromirrors are 17-micron squares of highly reflective aluminium alloy. This chip, which supports both the 768 x 576 pixel Phase Alternation Line (PAL) format (European broadcast standard) and the 640 x 480 pixel NTSC format, has 442,368 mirrors.

Each mirror square is attached at two diagonally opposite corners to support pillars; the attachments are highly flexible, extremely durable torsion bars. Both the pillars and the torsion bars are fabricated from the same metal as the mirrors. Each torsion bar is approximately five microns long and one micron wide. The support pillars suspend each mirror approximately two microns above the surface of the addressing circuitry.

The micromirrors are arranged in an X-Y array, and the chip also contains row drivers, column drivers and timing circuitry. The addressing circuitry under each mirror pixel is a memory cell that drives two electrodes under the mirror with complementary voltages. The electrodes are arrayed on opposite sides of the rotational axis. The mirror is held at ground potential through an electrical connection provided by the support pillars and the torsion bar attachments.

When the electrode on one side of the rotational axis is driven to a high logic level, the electrostatic attraction on that side of the axis rotates the mirror around the axis until the unattached mirror corner of that side touches a metal landing pad on the surface of the chip. The landing pad is fabricated from the same level of metal as the electrode, and it is held to the same potential as the mirror. When the high logic is applied to the other electrode, the mirror rotates in the other direction, and the opposite corner of the mirror square touches its own metallic landing pad.

The input data rates and data bus widths are designed and specified so that the entire memory/mirror array can be refreshed hundreds of times during a single video frame, to provide a display with 16 million possible colours. ❖

Product Review:

MORE SATELLITE TV PRODUCTS FROM AV-COMM

Although well known as one of the local pioneers in low cost satellite TV reception equipment, Sydney firm AV-COMM hasn't been resting on its laurels. Recently they sent us three of their new products to try out: a low cost dish alignment meter, a digital NTSC/PAL video standard converter and a video picture-in-picture encoder with inbuilt TV tuner. All three items are very reasonably priced.

by JIM ROWE

The smallest of the new products physically is the Dynalink SM-01 Satellite Meter (Cat. No. Q-1000), which measures only 153 x 128 x 58mm and weighs a modest 850 grams. Intended primarily for use 'in the field' by receiving dish installers, it has an inbuilt NiCad battery pack (charger supplied) and comes complete with a carry case and shoulder strap.

The prime function of the SM-01 is for use in dish alignment, and for this purpose it features a pair of 'F' series sockets which allow it to be connected temporarily in series with the IF cable from the dish LNB to the receiver inside. It even comes with a 2m length of RG-6/U coaxial cable, fitted with F series plugs, to make this connection easy.

Inside the meter, a wideband two-stage MMIC amplifier is used to feed a detector, producing a DC signal proportional to the overall strength of all signals in the 950-2050MHz band. This is used to drive the meter, via an adjustable gain control, so it becomes easy to adjust the dish/LNB orientation for maximum level.

Of course it can be tricky to make fine adjustments to a dish mount while you're simultaneously trying to watch a meter; but the designers of the SM-01 have thought of that too. In addition to the meter, they've provided a voltage-to-frequency converter driving a piezo speaker, so signal level can also be indicated by the varying pitch of an audio tone. This lets you align the dish 'by ear', adjusting for the highest-pitch tone.

Needless to say the audio tone can be disabled when you don't need it, so it doesn't drive you crackers!

Since the SM-01 is looped into the IF cable in order to indicate signal level, it is of course also in a position to monitor the LNB supply voltage and current drain — because the LNB's power is fed to it via the same cable, from the receiver. A couple of control buttons allow either parameter to be measured very easily, so you can verify that the LNB is receiving power and appears to be functioning correctly. Handy for troubleshooting...

As some of the latest dual-polarisation LNBs are in fact switched between vertical and horizontal polarisation by toggling the LNB supply voltage between +13V and +18V, the SM-01 also has a threshold detector which monitors the DC voltage and controls a pair of LEDs, marked 'V' and 'H', to indicate the nominal polarisation. This is again a handy feature.

I tried out the sample SM-01 with our test dish and LNB, and found that in practice it's not only very easy to set up, but convenient to use as well. The meter can be connected up simply by removing the IF cable from the LNB, attaching the 2m cable from the 'Antenna' input of the SM-01 instead and hooking the original cable to the 'Receiver' socket on the meter — all of which takes about one minute at most. Restoring the original cable connection afterwards is just as fast.

The adjustable sensitivity control lets you set either the meter or the audio tone for easy signal peaking, and you can check the LNB volts and current drain simply by pressing the appropriate button.

In short, then, the SM-01 seems to provide just about all of the facilities needed for fast and convenient 'on the spot' dish/LNB alignment and troubleshooting, in a compact and lightweight unit. For the quoted price of $490, it seems good value for money.

NTSC/PAL converter

Probably the most interesting of AV-COMM's new additions technically is the CDN-100P digital NTSC/PAL video standard converter (Cat. No. T-1400), which measures only 355 x 250 x 70mm and features automatic detection and conversion of NTSC to PAL. It's therefore ideal for the satellite TV enthusiast wanting to watch NTSC transmissions on international relay 'birds' — as well as people wanting to watch videotapes and laser discs from the USA — without having to invest in a multi-standard TV.

Only a few years ago, a full digital TV standard converter involved a rack of equipment and cost well over $100,000. Now a box the size of the CDN-100P, costing less than $1000, can do a very similar job — and although the picture quality may not be to full professional standards, it's more than adequate for 'consumer' applications.

Of course low-cost 'analog' NTSC/PAL converters have been available for a couple of years now, intended mainly to allow home video enthusiasts to watch NTSC videotapes and laser discs. But these sub-$200 units have a major shortcoming: they only perform a partial conversion, turning the 525-line 15,750/60Hz NTSC signal into a PAL signal with the same scanning rates — and hence the same number of lines.

This means that to watch the output of one of these converters on a standard PAL TV, you generally need to tweak not only the hold controls to lock the picture, but also the height control — to

The Dynalink SM-01 satellite meter connects between the dish LNB and satellite receiver, in series with the IF cable. It allows you to align the dish for a signal peak, monitoring this both with the meter and via an audio tone.

stretch the 525-line picture so that it fills the screen. Then when you switch back to a normal PAL signal, these controls have to be tweaked back again; a messy business, at best.

In addition, this kind of '525-line PAL' signal can't be recorded on a normal PAL VCR at all, because the VCR can't adjust to the different scanning frequencies.

Being a fully digital standard converter, the CDN-100P doesn't have these shortcomings. With inbuilt video A/D and D/A converters, together with a 4Mb frame store, it performs a full conversion and delivers a standard 625-line/15,625/50Hz PAL at the output. This means that you can feed its output video (and looped-through audio) to the A-V input of any standard PAL TV or VCR, for hassle-free viewing or recording.

The video A/D converter of the CDN-100P operates at a sampling rate of 14.318MHz for the luminance component, and 7.159MHz for the colour difference components. Both it and the output D/A converter achieve a rated picture resolution of 910 x 625 pixels, corresponding to a theoretical video response of around 7MHz — better than normal domestic reception.

A further advantage of the digital conversion process is that the output picture of the CDN-100P can be 'frozen' at any time, for a still picture display facility. There's also an inbuilt timebase correction function, for improved picture stability.

In short, then, the CDN-100P sounds like an ideal unit for anyone wanting to view and/or record video from NTSC sources, whether those sources are a satellite TV receiver or an NTSC VCR or laser disc player. But how does it perform in practice?

We tested out the sample unit on NTSC signals from both the satellite receiver (Optus B1 has NTSC from time to time), and an NTSC laser disc player, viewing them on two different standard PAL TV receivers and also recording them on two different PAL VCRs — including a fairly elderly National NV-370. In every case the CDN-100P performed its job in fully 'transparent' fashion, and the only real indication that an NTSC signal was being viewed or recorded was that the small front panel 'NTSC' indicator LED was glowing, rather than the 'PAL' LED.

Detection of NTSC and its conversion are fully automatic, and the output signal as viewed on a standard PAL TV is very clean and crisp — with no obvious artefacts. Similarly when it is recorded and played back, there's no clue that it's anything other than a standard PAL recording.

A colleague who is very experienced with VCRs and standards conversion said he thought he could detect a very slight deterioration in horizontal stability, on the signal as recorded and played back on one VCR, but agreed that the effect was very subtle.

Overall, then, we found the CDN-100P an excellent performer, and very good value indeed at the quoted price of $950.

By the way, AV-COMM also has available one of the much cheaper analog NTSC/PAL converters — the CP-100N (Cat. No. T-1250), priced at only $155.

PIP encoder/tuner

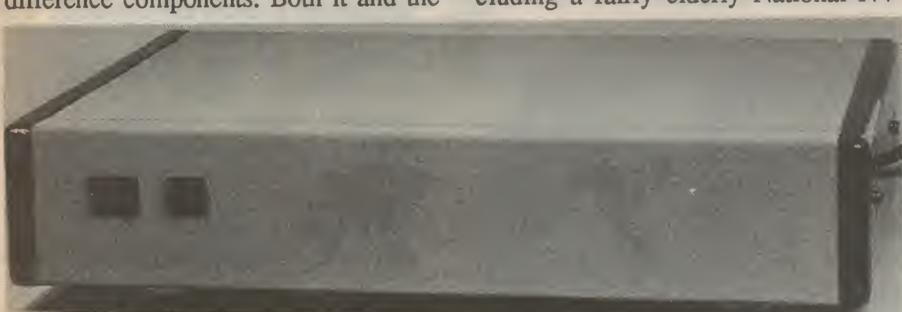
The third of AV-COMM's new additions is likely to be of interest not just to satellite TV enthusiasts, but to anyone who wants to be able to keep an eye on a second video signal while they're watching one of the normal TV programmes. Or in fact anyone who'd like to add 'picture-in-picture' (PIP) facilities, remote TV/A-V switching and other modern facilities to an existing TV receiver, for that matter...

What the Dynalink 'PIP View' unit (Cat. No. T-1800) provides is a remotely programmable 55-channel VHF/UHF tuner TV front end, combined with a digital PIP encoder/inserter which operates on both the TV signal and any of three selectable video inputs.

The unit has the ability to combine the TV and one of the video signals into a single image, in a variety of ways. You can have either one alone, filling the screen, or one as the 'main' picture and the other as a small 'sub' PIP image inset into it.

All of these options are controlled via a handheld IR remote unit, which is also used to select the TV channel. And whatever video combination you select, you can swap the 'main' and 'sub' signals at any time, at the touch of a button.

As you might expect, the audio ac-



The CDN-100P digital NTSC/PAL converter doesn't look very exciting, but does a most impressive job. Unlike cheap analog converters, it performs a full conversion — so you can even record the output on a standard PAL VCR.

Satellite TV products from Av-Comm

The Dynalink PIP View is quite compact, but combines a VHF/UHF TV receiver front end with a 'picture-in-picture' video switching and combining circuit. All of its functions are controlled from the IR remote unit shown.

companying the various video signals is switched with them, so the sound you hear at any time is that accompanying the 'main' image on the screen. (Although the sound for the 'sub' signal is actually made available via a 3.5mm stereo phone jack on the rear panel, so you *can* monitor it via headphones if you wish.) The audio switching is in duplicate for stereo, by the way, with L and R inputs for each of the three video inputs as well and L and R outputs.

Note that the outputs of the Dynalink PIP View are designed to connect to the direct A-V inputs of a standard TV receiver, consisting of composite PAL video and stereo audio. There's no RF remodulator; but then most of today's receivers have a direct A-V input, which gives better results anyway.

A nice feature of the unit is that when you're using the PIP function to display both the 'main' and 'sub' signals together, the small PIP image can be moved to any of four possible positions (near each corner), so it doesn't obscure a vital part of the main image. This is done using a 'Position' button on the remote, with repeated presses moving it in an anti-clockwise direction. You move it at any time, without disruption to either image.

As well as providing buttons for the control of PIP View's fancy image manipulation functions, the IR remote has an extended range of TV programming functions. This includes a 'Program' button, which causes the tuner to search the VHF or UHF bands for the available signals, and allows you to store them in the memory channels; a 'Scan' button, to view the various signals on stored channels; a 'Fine' tuning button (very handy!); a 'Mute' button, to temporarily silence the audio; and 'Up' and 'Down' buttons for the audio level. In short, just about every facility you'd expect to find on one of the latest top-of-the-range sets, except stereo TV reception.

The PIP View is surprisingly compact, measuring only 264 x 179 x 40mm. This has been achieved by using a separate power supply, which is one of the type with a mains cable permanently attached at one end, and the output cable attached to the other. The latter has a five-pin DIN plug on the end, and mates with a socket on the rear of the main unit.

And how does the Dynalink PIP View unit perform in practice? We tried it out, with a typical 'no frills' TV receiver, together with the satellite TV receiver and a VCR. The results were very impressive, showing for a start how many convenient facilities the PIP View adds to this kind of a setup — not the least being remote channel selection and volume control, plus selection of any of the three A-V signals as an alternative to the TV signal.

Then there's the PIP facility itself, of course. This is not something that you tend to use all the time, but it's certainly handy for keeping an eye on a satellite transponder while you're watching a TV programme, or a monitoring a TV channel while you're watching a video. I found myself using it quite a bit during the week of NASA's Hubble Telescope Repair Mission, for example, so I could keep an eye out for news updates on the transponder carrying CNN...

Although the PIP image is quite small (only about 1/8 of the main image area), it's fairly clear — quite clear enough for you to read even medium-sized titles, and see what's going on.

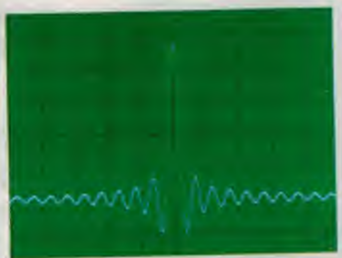
I did notice a strange 'pulsing brightness' effect in the PIP image when the 'Sub' signal was a satellite signal which was fairly dark, but otherwise the performance was fine.

In summary, then, the Dynalink PIP View adds quite a few very nice facilities to an existing TV receiver/VCR setup, and should therefore appeal to quite a few people apart from its obvious uses for satellite TV enthusiasts. For the quoted price of $399 it again seems good value for money.

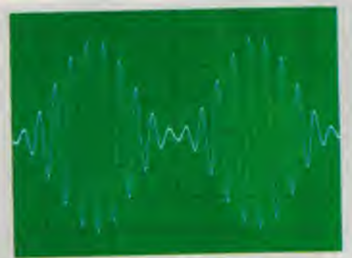
Further information on any of these three new products is available from AV-COMM Pty Ltd, PO Box 225, Balgowlah 2093; phone (02) 949 7417 or fax (02) 949 7095. Our thanks to AV-COMM's Garry Cratt for the opportunity to try them out on your behalf. ❖

The rear view of the PIP View unit. As you can see, it has an RF input for the TV front end plus four sets of video and audio connectors — one set for the A-V outputs, and the other three for the A-V inputs.

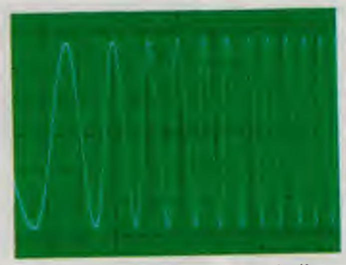
There are many areas where our function generator will surpass your expectations.



A built-in 12-bit, 40 MSample/sec, 16K deep arbitrary waveform generator easily handles your custom waveform needs.



Internal AM, FM, FSK and burst modulation eliminate your need for a second modulation source.



Both linear and log sweeps are built in, making filter and amplifier testing quick and easy.

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In the world of function generators, price and performance have always been synonymous. So it's understandable you'd expect to pay more for the measure of confidence you get with a synthesised signal source that delivers stable, accurate signals test after test. Or, for the flexibility to generate complex waveforms with arbitrary waveform capability.

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New DMM's from Jaycar

Jaycar Electronics has added three new models to its range of handheld digital multimeters — two of which are full-feature models offering high-contrast LCD readout with very readable digits 20mm high. The third unit is an economy model, but with an unusually wide range of measurement functions.

Most elaborate of the new Jaycar DMMs is the QM1310, a compact, rugged 3.5-digit instrument in a standard yellow impact-resistant plastic case measuring 170 x 88 x 38mm. The case has a swing-out tilting bail built into the rear, and is claimed to withstand a 1m fall onto a concrete surface. It also features fully guarded input jacks, for operator safety.

Based on a dual-slope CMOS A-D converter chip, the QM1310 features auto zeroing, polarity selection and over-range indication coupled with manual range selection via a 30-position rotary switch. A pushbutton is used for ON/OFF control, but the meter also powers off automatically if the meter has not been used for about 15 minutes. The measurement ranges provided cover volts and current for both DC and AC, resistance, capacitance, frequency and bipolar transistor h_{FE}.

The basic rated accuracy of the instrument on the DCV ranges is 0.5% +/-1 digit, derated to 3% +/-7 digits in the case of the 20A AC range.

There are five DC volts ranges, with full-scale readings of 200mV, 2V, 20V, 200V and 1kV respectively. The five ACV ranges cover much the same range, apart from the top range which is only 700V FSR. There are four ranges for DC current, with FSR figures from 2mA to 20A, and two for AC current with FSR figures of 200mA and 20A.

For resistance the QM1310 provides no less than seven ranges, the lowest having an FSR of 200 ohms and the highest 200M. There's also a diode/continuity range, with both resistance measurement and a piezo buzzer which sounds is the test circuit resistance is less than 30 ohms.

There are five capacitance ranges, with FSR figures ranging from 2000pF (resolution 1pF) to 20uF (resolution 10nF). The single frequency range measures up to 20kHz, with a resolution of 10Hz, while the bipolar transistor h_{FE} range measures the approximate beta of either NPN or PNP transistors, at a base current of 10uA and a V_{CE} of 2.5V — which should be quite handy for go/no go testing, and also matching of low power devices.

With this wide selection of ranges, coupled with an LCD readout offering high-contrast digits 20mm high, the QM1310 should be a most useful and practical instrument for general testing. It comes complete with test leads for $79.95, which represents excellent value for money.

Next in the lineup of new instruments is the QM1300, similar in size and appearance to the QM1310 but with a 'taper' of the case at the top. Based also on a dual-slope CMOS A-D chip, this instrument again features a 3.5-digit LCD with 20mm-high digits, a basic accuracy of 0.5% and a 30-position rotary range switch; however the range mix is different, lacking the capacitance and frequency functions.

Here again there are five DCV ranges, with the same FSR figures as before; but there's now a fifth ACV range, with an FSR of 200mV. Similarly there are now no less than seven ranges for DC current (20uA - 20A FSR), and exactly the same number of AC current ranges, with the same FSR figures.

On the other hand, there's one fewer resistance range; the 200M range has disappeared. The diode/continuity range is still provided, though, as is h_{FE} measurement for low power bipolars.

In short, then, although the QM1300 lacks the capacitance, frequency and high resistance measuring capabilities of the QM1310, it actually provides more ranges for measuring voltage and current, so for some users it may be preferable. At the quoted price of only $49.95 including test leads, it too seems excellent value for money.

Finally, there's Jaycar's new QM1500, which comes in a somewhat smaller dark grey case (126 x 70 x 24mm) and has a 3.5-digit LCD readout with high-contrast digits 12mm high. It has a 20-position rotary switch, which performs both ON/OFF control and range switching.

Despite its more modest pretensions, the QM1500 still provides a rated basic accuracy of 0.5% and a very useful set of measurement ranges. There are five DCV ranges, from 200mV to 1000V FSR; two ACV ranges, 200V and 750V FSR; five DC current ranges, from 200uA to 10A FSR; five resistance ranges, from 200 ohms to 2M FSR; a diode forward drop range; and even a bipolar transistor h_{FE} range.

Bearing in mind the QM1500 is priced at only $29.95, including test leads, this should make it an excellent choice for the young beginner to electronics who wants the most meter for the least outlay.

All three of these new DMMS are available in all Jaycar stores. (J.R.)

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

32-bit 'SHARC' DSP processor

Analog Devices has announced a new class of single chip DSPs (digital signal processors) which target current and emerging applications in audio/speech, telecom, imaging/graphics, numerical processing, and instrumentation.

The ADSP-21060 is the industry's first DSP in the class of 'Super Harvard ARchitecture Computer (SHARC). It integrates what is claimed to be the industry's fastest general purpose floating-point core (the ADSP-21020) with a dual ported 4Mb SRAM, communication ports and a sophisticated DMA (direct memory access) controller, on a single chip. The 21060 features a 40MIPS (million instructions per second) processing speed. A number of peripherals are integrated on-chip for high speed I/O

processing, including: 10 simultaneous DMA (direct memory access) channels; highly efficient host system/interconnect bus interfaces; external communications ports (six link ports, two serial ports); SHARC scalable multi-processing hooks.

The ASD-21060 and future SHARC processors will offer designers a single chip with clear performance, bandwidth, size and power advantages over traditional DSPs and processors — and at lower system cost than designs based on standard DSP and embedded RISC based chipsets.

Also available is release 3.0 ADSP-210xx development software, to introduce the ADSP-21060 Simulator. Release 3.0 provides a fully development suite, including an instruction level simulator, assembler, linker, a C-compiler and an extensive C runtime library — allowing designers to easily harness the ADSP-21060's advanced interface capabilities and on-chip SRAM, in stand alone and multiprocessor systems.

For further information circle 271 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970.

Compact 7-segment LED displays

Hewlett Packard has introduced a new family of ultra-miniature seven segment LED displays which provide full 8mm character height in a more compact package than HP's standard 7.6mm displays. The combination of larger character size and smaller package dimensions makes this new family of LED displays HP's most space efficient character size, perfect for use in today's compact industrial and consumer product designs. Typical industrial applications include temperature controllers, timers and digital panel meters; typical consumer applications include various appliances with LED readouts for time, temperature and other numeric information.

These compact displays are available in either grey or black surfaces, and in standard, high efficiency and 'super-efficient' colours of A1GaAs red, orange, yellow or green colours. They offer a combination of high light output, high peak current capability, with evenly lighted segments and mitred corners on segments for a pleasing appearance.

For further information circle 272 on the reader service coupon or contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064; phone (02) 439 4655.

Low harmonic SMP supplies

To reduce the harmonic content of switched mode power supplies for TV sets and monitors, Siemens has developed a set of control chips which produce a sinusoidal current output for flyback power supplies.

Ongoing standardisation is making the allowable harmonic content of screen power supplies much lower than it used to be. First to benefit are sets with a power consumption above 75W. A maximum current of 3.4mA per watt of power is required for the fourth harmonic, corresponding to a permissible current of 2.3mA for the third harmonic. The limit value of the sixth harmonic is 1.14A, and for the eighth harmonic it is 0.77A.

Switched mode power supplies containing the new chips operate with pulsating DC. A sinusoidal current input can be implemented at very reasonable cost up to 200W of power. A pre-switching stage is recommended for consumptions above this.

For further information circle 274 on the reader service coupon or contact Siemens Advanced Information Products, 544 Church Street, Richmond 3121; phone (03) 420 7345, fax 420 7275.

Triple output supply controller

The Maxim MAX782 power supply controller is a systems engineered device which provides regulated supply voltages for notebook computers and other battery powered equipment. It includes dual PCMCIA (Vpp) outputs, and step down regulators for 3.3V and 5V. Three precision comparators perform low battery detection, and two low dropout, micro-power linear regulators act as backup supplies for CMOS RAM and real time clocks.

Efficiency for the main 3.3V/5V supplies is as high as 95% for 2A loads, and greater than 80% for loads from 3mA to 3A. Patented Idle-Mode operation governs the regulation at light loads. At heavier loads, the operation shifts automatically to synchronous rectification and pulse width modulation (PWM). High operating frequency (200kHz or 300kHz) allows use of physically small external components, and the current mode PWM architecture permits filter-capacitor values as small as 30uF per ampere of load.

The MAX782 has fast AC response, thanks to a high (60kHz) unity-gain crossover frequency which enables recovery from line and load transients within four to five clock cycles. High level integration and low cost external N-channel MOSFETs lower the system costs.

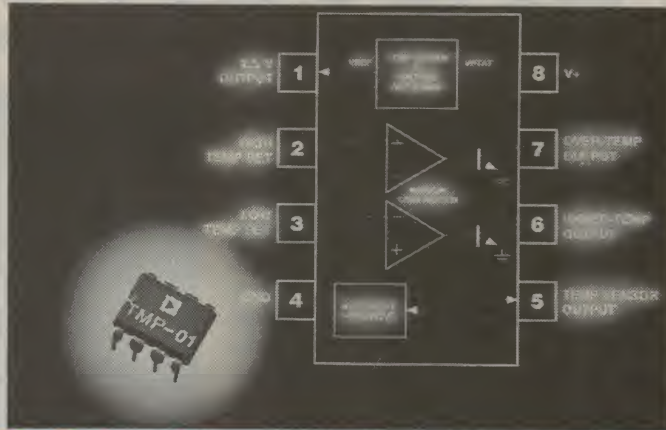
Lowering costs even further is an integral flyback-winding controller, which generates the high side 15V output. The input range is 5.5V to 3V, and the quiescent current is 420uA, dropping to 70uA in standby mode (when only the linear regulators are active). Other features include low noise, fixed frequency PWM operation for moderate to heavy loads,

Single-chip temperature controller

Analog Devices offers a simple solution for applications requiring a low cost, single chip temperature controller. The TMP-01 is a temperature sensor, which generates a voltage output proportional to absolute temperature and a control signal from one of two outputs, when the device is above or below a specific temperature range. Combining a programmable thermostat with an accurate onboard temperature in a small 8-pin DIP, SOIC, or TO-99 package, the TMP-01 is ideal for temperature control applications, ranging from protection of electronic circuits to commercial appliances, to HVAC (heating, ventilation, air conditioning) systems.

The TMP-01 operates from a single 4.5 to 13.2 supply, and requires only 450uA of quiescent current when operated with a 5V supply. An onboard reference provides a stable 2.5V output, as well as a sensor output voltage which has a precise temperature coefficient of 5mV/K (nominally 1.49V at 25°C). Accuracy is typically +/-2°C over the TMP-01's temperature range. A pair of onboard window comparators generate an open-collector output signal when high or low thresholds are exceeded. Both the high and low temperature trip points and the hysteresis band are programmable by external resistors.

For further information circle 282 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970, fax 899 5191.



... and a synchronisable oscillator for noise-sensitive applications such as communicating computers and electromagnetic pen based systems.

For further information circle 278 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511, fax 808 5473.

RS-232 transceiver operates on 3.3V

The Maxim MAX212, a 3.3V powered RS-232 transceiver, handles high data rates (120kbps guaranteed) at low power (5mA maximum at 3.3V). And, at only 3V of Vcc, the MAX212 can drive a mouse. The CMOS MAX212's three transmitters and five receivers meet EIA/TIA-232E specifications.

The MAX212 is compatible with EIA/TIA-232E, EIA/TIA-562 and V.28/V.24 serial interface standards. For Vcc levels as low as 3.0V, it guarantees 4V/us minimum slew rates, 120kbps minimum data rates, and +/-4V minimum output swings.

For further information circle 276 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511, fax 808 5473.

Surface-mounted side-emitting LEDs

Designers who begrudge every tenth of a millimetre when designing devices will find the latest addition to the Siemens TOPLED family invaluable. The SIDELED (side emitting light diode) provides another surface mounting variant whose optical axis runs parallel to the circuit board at a distance of just 2.5mm. The LED is available in all normal emission colours in the visible range.

They are designated L*A67X (where * standards for a letter indicating the colour, i.e., 'O' for orange.) The optical design of the SIDELEDs is the same as that of the TOPLED range. This means that all the associated optical features, such as lenses, reflectors and light guides can also be used. Another application for these LEDs is for background lighting of liquid crystal displays, where the light has to be coupled in from the side, due to space restraints. The infrared/DET version SFH4XX/SFH3XX (with optical daylight stop filter) makes simple fork or reflex photoelectric barriers possible. The surface mount package is designed for reflow soldering (infrared/vapour phase).

For further information circle 273 on the reader service coupon or contact Siemens Advanced Information Products, 544 Church Street, Richmond 3121; phone (03) 420 7345, fax 420 7275.

IGBT modules handle 1200V

International Rectifier has expanded its insulated gate bipolar transistor (IGBT) family by introducing its first 1200V modules. The family of 12 modules, with current ratings ranging from 25 to 100A, includes both half bridge and chopper circuit configurations.

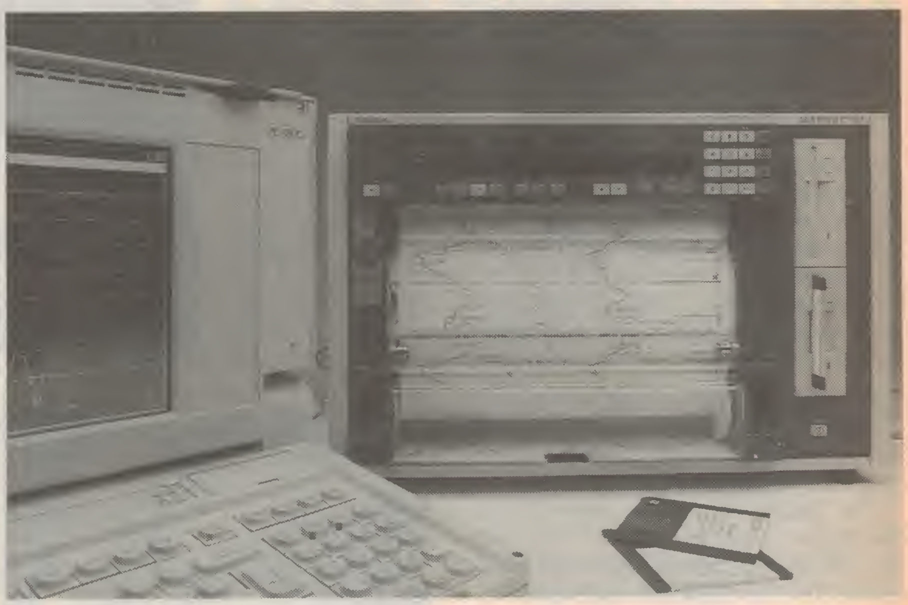
The combination of industry-leading IGBTs and complementary HEXFRED fast recovery epitaxial diodes in a single Int-a-Pak package offers the designer both power and efficiency. The family's flagship device is the half bridge 100A module, designed the IRGTIO100M12.

The modules offer a number of particular advantages to motor drive manufacturers, including a guarantee of a 10us short circuit capability and 2500V isolation from the heatsink. They are low Vce(on) devices, with a typical specification of 2.5V at rated current, and are most efficient at frequencies up to 7kHz.

For further information circle 279 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970. ❖

NEW PRODUCTS

Chart recorder has FD storage



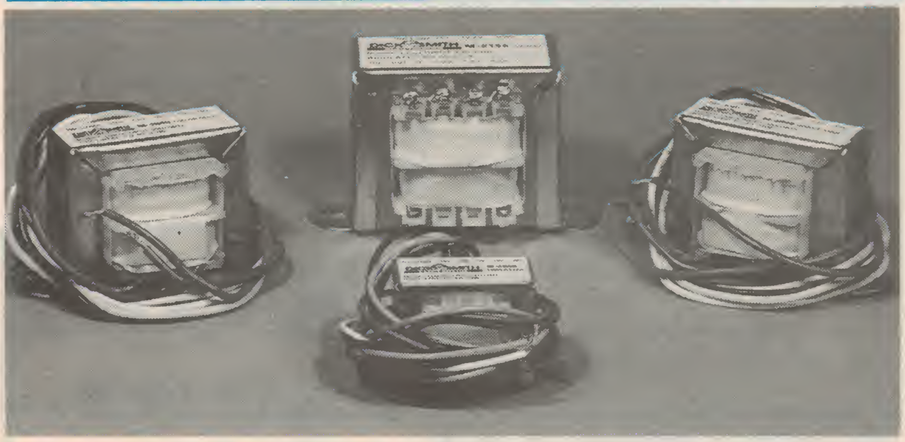
The new Multireg C1732 hybrid recorder from Siemens Automation Group now also stores data online with two integrated floppy drives — parallel to the graphic representation in seven colours. Further processing and analysis of the data stored on diskette is possible with Siemens Sirec software (or commercially available standard evaluation programs) on an AT-PC under Windows. A parallel or serial interface permits PC coupling for parameter and measured value transmission.

The Multireg C1732 only requires 1.5s for scanning the 32 channels. Users can select each channel for the current, voltage, temperature and resistance signal ranges. For this purpose, they program the recorder under menu control by means of function keys. At the same time, they determine which channels are to be documented by the low noise piezo writing system in immediately visible, high contrast diagrams. Together with the measured values, data such as channel number, date, time, limit values or complete measured value tables and programmable messages can be printed out.

Siemens offer the new hybrid recorder in three housing versions: 'Multireg C1732' in desk or 19" flush mounting units, and 'Piezograph 2' for panel mounting.

For further information circle 241 on the reader service coupon or contact Siemens Power Plant Automation Department, 544 Church Street, Richmond 3121; phone (03) 420 7449.

DSE expands transformer range



Dick Smith Electronics has expanded its range of power transformers for electronic equipment, with the addition of three new models rated at 30VA, 15VA and 5VA respectively. All three transformers are insulated to AS 3108.

The M-2156 has a 15V secondary winding tapped at 12.6V, 9.5V, 8.5V, 7.5V and 6.3V, and with a current rating of 2A. It is intended for higher power applications than the existing M-2155.

The M-2860 has a 15V-0-15V secondary, tapped at 7.5V on either side and with a current rating of 500mA. It is suitable for applications requiring lower currents than the M-2155.

Finally the M-2856 has an 18V-0-18V secondary, tapped at 15V on either side and intended for applications requiring higher voltage than the existing M-2851, but with a similarly low current drain.

The M-2156 is priced at $16.95; the M-2860 at $14.95 and the M-2856 at $8.95. All three are now available from all DSE stores and stockists.

New Tektronix DMMs

Tektronix has unveiled what it claims are three new price/performance leaders in its rapidly expanding handheld digital multimeter product line.

The new instruments are the DM255, DM256 and DM257 general purpose multimeters. Each is designed and manufactured to comply with safety standards established by UL and IEC and conform to Mil-T28800, Class 2 standard for shock and vibration.

The MD255 features a 3.5 digit display, 0.7% accuracy, autoranging or manual selection, data hold and current measurements. Where current measurements are not needed, the DM256 offers testing of voltage, capacitance, resistance and diodes with 0.5% accuracy, a fast continuity beeper and memory offset. The DM257 offers current and capacitance measurements with 0.5% accuracy, autoranging and manual selection, and a low battery indicator.

For further information circle 242 on the reader service coupon or contact

Tektronix, 80 Waterloo Road, North Ryde 2113; phone (020 888 7055.

Radio control modules

McLean Automation has introduced the 'bricks' — a range of portable radio control modules all housed in Clipsal 265/5 (210 x 110 x 80mm) enclosures with carry bar. Similar in appearance to a house brick with a handle, these rugged units are affordable, Australian-made industrial remote control devices.

The brick series extends from simple single button toggle-style transmitters, to multi-code transceivers capable of actuating multiple remote loads with separate on/off coding and receiving 'loop back' acknowledgements of switching function.

The following features characterise the shape of bricks to come: 2km range from a radio licence-exempt HF transmitter, with excellent long wavelength diffraction performance around obstacles in the propagation path; six to 12 months service from economical replaceable dry cells; convenient operation for gloved hands from robust 20mm weatherproof press buttons mounted on minimum 40mm centres; positive audio annunication of all transmissions; complete compatibility with the company's existing range of mains or DC-powered multicode switching receivers; fully digitally coded, crystal-locked FM signally, with security byte and stringent code recognition requirements; and keyed arming switches, differential code related transmit power levels and battery status lamps included, where appropriate.

For further information circle 245 on the reader service coupon or contact McLean Automation, PO Box 70, Freemans Reach 2756; phone/fax (045) 796 365.

Modular desoldering system

OK Industries has introduced its updated modular desoldering system. From a single power base, which includes an ultra-high efficiency vacuum pump, the BTR-1000 provides maximum application flexibility for soldering, and desoldering operations — for both conventional and SMT components.

With this system, a user can select one of four specialised handpieces to perform a variety of tasks, including: standard and high thermal-demand desoldering (DG28110 handpiece), SMT component removal (SAI-644 SMTweezers), standard and high thermal demand soldering (SAI-690 high power iron) and fine SMT touch-up soldering (SAI-640 micro iron).

The BTR-1000 is suited for a variety of work environments by virtue of its interchangeable temperature control modules. This provides a user selectable choice of four temperature control modules.

For maximum supervisory control of operating temperatures, OEMs prefer the FTM-1 (fixed temperature module) or TTM-1 (tri-temperature module), where the operator is limited to one or three temperature settings, respectively.

The variable temperature module, VTM-1, and the DTM-1, variable temperature module with digital readout, are favoured in service areas and engineering labs.

The BTR-1000 conforms to MIL-STD-1686A and MIL-STD-2000A, using static dissipative materials and incorporating zero voltage switching, <2.0mV AC leakage, <5.0 ohm nozzle-to-ground resistance, and idle temperature repeatability better than +/-5°C. A combination of RTD sensor feedback, 110W power and high mass desoldering nozzle provides a very efficient and consistent desoldering system, particularly for high thermal demand boards.

For further information circle 249 on the reader service coupon or contact Electronic Development Sales, 11 - 13 Orion Road, Lane Cove 2066; phone (02) 418 6999, fax 418 6550.

NEW PRODUCTS

Multipurpose tester

A transister and diode check, plus 50Hz signal generator and audible continuity check, extend the usefulness of the 3.5 digit Scope Model M832 multimeter. Scope has also released the model M838, another 19-range 3.5 digit pocket meter, which offers a temperature measuring function instead of low frequency signal generation.

Both have ACV, DCA to 10A, DCV, ohms, audible continuity, plus hFE/NPN/PNP transistor and diode check. Test leads are standard and self selection blister pack is included.

For further information circle 244 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

Current clamp meter

Nishizawa of Japan has introduced the model 5127 Clamp-on Tester, a rugged, multi-range AC current clamp, with AC and DC voltage measurement capabilities plus a resistance function.

The instrument will measure AC current to 300A in six ranges, up to 750V AC in three ranges, 0 - 75V DC, and up to 100k in two resistance ranges. Basic accuracy is +/-3% FSD. Temperature measurements from -50 to +150°C are also possible using the optional 9021-01 thermistor probe. The unit's insulated clamp will accommodate cables up to 33mm diameter, and the drop-proof movement incorporates a convenient meter lock to enable readings to be held — for example, when taking measurements in hard to get at places. Overload protection is proved by 0.5A/250V non-arcing fuses, both in the instrument and test lead. The 5127 is supplied complete with test leads, spare fuse, and is housed in a durable black carrying case.

For further infomation circle 247 on the reader service coupon or contact Nilsen Instruments, PO Box 930, Carlton South 3053; phone (03) 347 9166.

Laptop DSO

The Hitachi VC-5430 is a sub-notebook size digital oscilloscope with colour TFT liquid crystal display, which weights only 2kg — including the battery. The instrument is packaged in a new configuration which does not limit the locations in which it can be used, offering easy operation, waveform observation, and high portability.

Two newly developed LSI devices allow it to achieve both compactness and light weight, while a high density 4" colour TFT liquid crystal display, with high speed refresh provides display quality rivalling that of CRTs.

The oscilloscope provides top flight performance as well. It enables high speed 30MSps sampling (8-bit resolution) simultaneously on two channels, 50MHz bandwidth, a 2k word memory capacity for each channel, a battery backed-up memory capable of saving 100 waveforms, and RS-232C interface (provied as standard), fully programmable operation, automatic go-nogo waveform comparison, frequency-divided trigger, automatic pulse parameter measurements, and auto-setup.

In addition, to enable observation of ungrounded communications circuits, there are newly developed features such as differential inputs, differential triggering, a resume function which eliminates the trouble of starting and ending measurements, an automatic power-off function, and a timer function which enables unmanned data collection over long periods of time.

For further information circle 243 on the reader service coupon or contact Warburton Franki, 1-5 Carter Street, Lidcombe 2141; phone (02) 364 1700. ❖

Special Feature:

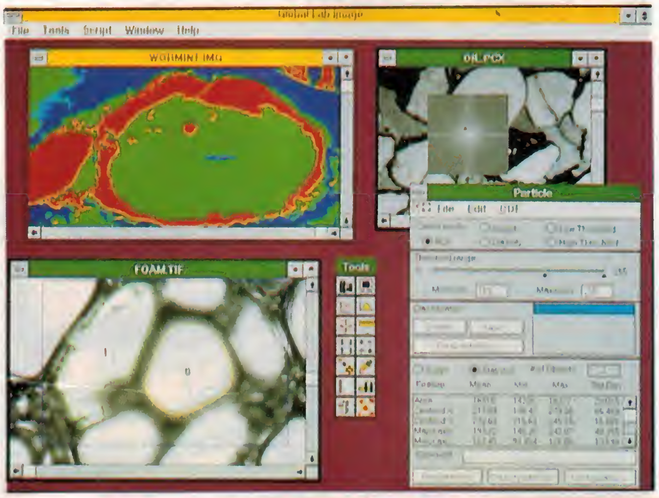
Enhancements for personal computers

High accuracy frame grabber

High accuracy image analysis for demanding applications such as microscopy and metrology is now available at a dramatically reduced cost, with the introduction of the Fidelity 100 for just $3200. The board uses proprietary circuitry to enable users to digitise images with unsurpassed accuracy from a wide variety of video sources, with up to 1k by 1k spatial resolution.

The Fidelity 100 is designed specifically for use with EISA bus computers and Microsoft Windows 3.1. Its architecture allows the board to integrate seamlessly into the host system, taking maximum advantage of the power of new PCs. Using a high performance 33MB per second EISA bus interface, images can be transferred rapidly from the board to the host system for display and processing.

Fidelity 100 ships with Global LAB Acquire software for Windows, an easy-to-use startup application which allows users (including inexperienced imaging researchers) to display live video and capture, save and print images.



For further information circle 207 on the reader service coupon or contact TCG, 30 Balfour Street, Chippendale 2008; phone (02) 698 5000.

Fast modems from NetComm

Pushing the limits of the current analog telephone system, NetComm has announced a new modem range incorporating the new 28.8kbps-capable chipset from Rockwell International. With products in the lab transmitting successfully at 28.8kbps, NetComm is confident that it will be shipping the new 'V.FAST' Class modems in the first quarter of 1994.

The new V.FAST Class Modems are expected to provide real benefits to users who regularly download information from bulletin board systems, transmit large documents within corporations, connect remote offices to corporate LANs and attach program files to their mail messages.

NetComm will be releasing three new models of its SmartModem family. The SmartModem M11F will support speeds up to 28.8kbps, whilst the SmartModem M10F will support speeds up to 24kbps, and the SmartModem M9F will support speeds of up to 19.2kbps. These new products will be priced competitively, with prices ranging from $1499 to $1299. The AutoModem family will also have two new products added to the existing range, the 28.8kbps AutoModem E11F ($1299) and the 19.2kbps Automodem E9F ($1099). Speeds quoted are based on sending uncompressed data. A higher throughput can be achieved when using compression. An important feature of the V.FAST class protocol is the ability to test the line quality during the initial hardware handshake, to determine the highest speed supportable for that connection, since not all lines will be able to support 28.8kbps. All of this is done without the need to use the MNP 10 error correction protocol. MNP 10 is also included in the new

Half size DAS card

The PCL-818H is a high speed, high performance, multifunction card with a difference. It is the forerunner of a new range of PC-LabCards designed around Advantech's AD1801 — a fully customised ASIC chip using 1.0 micron CMOS technology.

The functions offered by the new card include: A/D conversion, D/A conversion, digital I/O and timer/counter. Either 16 single ended or eight differential analog input channels are offered, each with 12-bit resolution and programmable gain control. One 12-bit output channel completes the analog I/O complement. An automatic channel scanning circuit permits high speed multiple channel sampling in DMA mode. Onboard SRAM stores individual channel-gain values, enabling the PCL-818H to perform auto channel scanning with different gains for each channel, at a sampling rate of 100k, together with data transfer in DMA mode. The card is fully software compatible with its predecessor (the PCL-818) which means immediate software support and the choice of a wide range of external signal conditioning boards.

For further information circle 201 on the reader service coupon or contact Priority Electronics, 23 Melrose Street, Sandringham 3191; phone (03) 521 0266, fax 521 0356.

SmartModem and AutoModem products as it allows the modem to continually adapt the line speed to line quality. V.FAST Class is an interim standard, released by Rockwell International to provide users with the ability to transmit data at throughput rates of up to 28.8kbps (115.2kbps with compression using V.42bis), without having to invest in a dedicated ISDN line).

For further information circle 173 on the reader service coupon or contact NetComm Australia, PO Box 379, North Ryde 2113; phone (02) 888 5533, fax 887 2839.

64-bit graphics accelerator card

The Matrox MGA II (Multimedia Graphics Architecture) is a 64-bit graphics accelerator card with PCI interface. Based on Matrox's own 64-bit graphics chip, it is designed for both the latest high speed PCI bus and the VESA local bus (VL).

Claimed to be ideal for Windows, CAD and multimedia users involved with desktop publishing, image touch-ups, complex spreadsheets, video for Windows playback and real time 2D manipulation for CAD, the MGA II will deliver Winmark 3.11 scores of 90 million in 8-bit colour, or 30 million Winmarks in 24-bit colour. The board comes in three memory configurations: 2MB, 2MB with additional 2MB upgrade facility, and 4MB. The 2MB non-upgradeable board offers 24-bit colour, (16.7 million colours) at 800 x 600 resolution, and 8-bit colour, (256 colours) at 1280 x 1024 resolution; while the upgradeable board offers 24-bit colour in 800 x 600 and 8-bit colour up to 1600 x 1200.

The 4MB board offers added speed and accelerated 24-bit colour in resolutions up to 1152 x 882, and 15-bit colour up to 1600 x 1200. The three boards are selling for $995, $1190 and $1695, respectively.

For further information circle 165 on the reader service card, or contact TCG, 30 Balfour Street, Chippendale 2008; phone (02) 699 8300. ❖

Silicon Valley NEWSLETTER

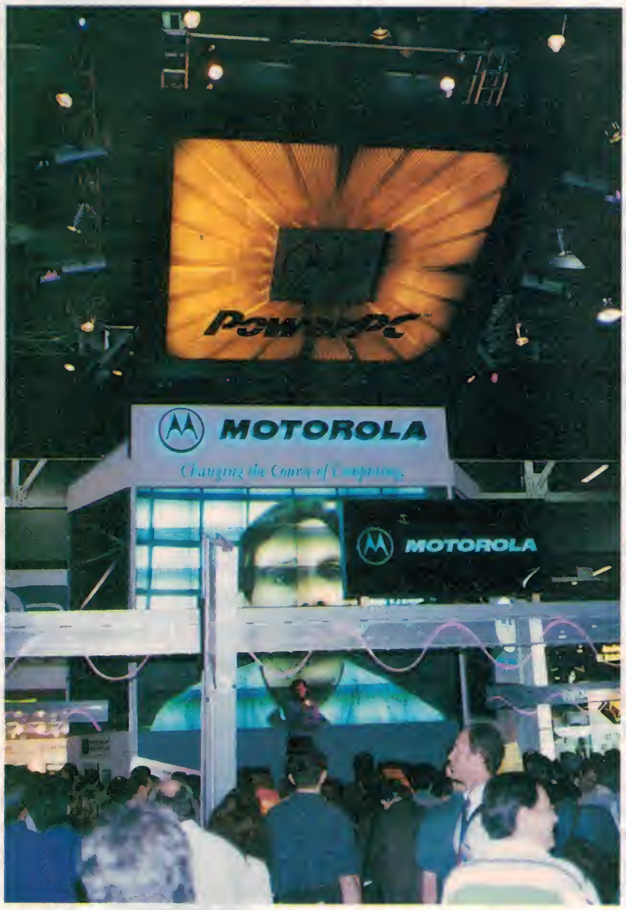
US chip industry unites behind GATT

The historic GATT trade agreement reached in December is believed to represent a huge victory for Intel and a potential big loss for IBM and other chip makers. However, most of the US semiconductor industry quickly united in their support for the overall GATT agreement.

In the last minute backroom negotiations between US Trade Representative Mickey Kantor and his European counterparts, Kantor, in a desperate effort to reach a new GATT agreement by the December 15 deadline, negotiated away a key trade concession sought by Intel.

During the negotiations of the past year, Intel had insisted on the elimination of language in the earlier GATT draft agreement that would have allowed foreign governments to force companies to licence their technology to local firms, to manufacture some or all of the products the foreign company intends to sell in their country.

Ultimately, the Clinton Administration insisted that the provision be taken out of the GATT deal. In return, the US agreed to drop another hard-fought concession regarding the protection of intellectual property.



At the recent Comdex show in Las Vegas, Motorola made a big impact with this stand featuring a huge replica of the firm's new PowerPC microprocessor chip. Beneath it was a multi-screen video theatre promoting the features of this 'next generation' micro, destined for use in many of the new PC's.

Officials at IBM said Intel's fears of losing control over their technology through manufacturing partnerships are groundless. On the other hand, the failure of the US to include the agreement on protection of intellectual property is very likely to cost US computer semiconductor and software companies billions of dollars in business, as certain countries will continue to ignore intellectual property rights.

US semiconductor industry officials, however, quickly acted to voice their support for the GATT agreement, particularly after Clinton Administration officials reassured them that proposals which would have eliminated anti-dumping laws were defeated and other efforts to erode intellectual property laws had been beaten back by the US negotiators.

Industry officials were particularly pleased that the GATT agreement will cause European tariffs on US-made semiconductors to decline from 14% to 10% over the next 10 years.

"Overall, we are satisfied with the progress made in GATT talks," said Andy Procassini, president of the Semiconductor Industry Association in San Jose. "We aren't really that far ahead of where we were on tariffs, but I wouldn't minimise the importance of beating back some of the bad proposals."

In particular, the SIA was pleased to see that the practice of 'compulsory licensing' by which governments can force companies like Intel to licence foreign companies to manufacture their products, was eliminated from the GATT agreement. That would have been a show stopper," said National Semiconductor vice president George Scalise, who played an instrumental role in the drafting of the first US-Japanese Chip Trade Agreement in 1986. American chip makers considered the provision as giving foreign governments a licence to steal business and technology.

US chip industry is back on top

The US semiconductor industry has regained worldwide leadership for the first time since 1985, according to new market figures released by Dataquest in San Jose. The market research company said US firms sold 41.9% of the US$88 billion in 1993 chip sales, an 0.4% gain over the 1992 market share. Japan's share dropped nearly a full percentage point to 41.4%.

The surge of the US industry was headed by Intel, Motorola, Texas Instruments and IBM. Collectively, these four companies accounted for 25% of the world semiconductor market.

Dataquest said the US rebound continued to be driven by a combination of factors, including a booming personal computer market, the effects of the second US-Japanese Chip Trade Agreement, the impact of Sematech on manufacturing capabilities, a technology migration from analog to digital — in

which US companies maintain a lead over their Japanese competitors — and a determined strategy by most US chip makers to focus on developing high value components such as microprocessors and other logic chips. At the same time, Japan's industry is feeling the effects of the recession in its domestic market and the worldwide lull in consumer electronics demand.

"The declining Japanese economy, coupled with increased foreign competition has allowed US companies to jump back into the worldwide lead," said Gene Norrett, a Dataquest vice president in charge of the semiconductor group.

Compromise on data encryption chip

After a three year stand off, the US computer industry and the White House have compromised on a controversial proposal which would give US spy and law enforcement agencies access to data secured by sophisticated 'Clipper' data scrambling chips. Under the terms of the proposed compromise, the US computer and telecommunications industries would accept the government's Clipper chip proposal in return for the relaxation of export controls on various other data encryption software and hardware products.

Increasingly, computers, telephone, and other communications systems are sold with advanced data encryption chips which would make eavesdropping on sensitive voice and data transmission virtually impossible. The US government has insisted that spy agencies such as the National Security Agency, the FBI, and other law enforcement agencies must be allowed access to the data as part of criminal investigations or out of national security concerns.

Industry leaders had argued that providing the government with the codes to access scrambled voice and data calls would limit their ability to sell the machines, particularly in overseas markets where competitors could offer similar systems that cannot be accessed by US government agencies.

In a letter to president Clinton, the Digital Privacy & Security Group, which represents the computer and communications industries, said they can now accept the Clipper proposals from the government, as it would allow them to start exporting various data coding software systems to international markets. Until now that kind of software has remained bound by very strict export restrictions.

Applied Materials breaks billion

With an incredible 43.7% jump in sales, chip equipment maker Applied Materials has joined the group of Silicon Valley high-tech companies with annual revenues of US$1 billion or more.

Applied said its sales soared to US$1.08 billion in fiscal 1993, up from US$751.4 million in fiscal 1992. Profits more than doubled, from US$39.5 million to US$99.7 million. During the most recent fourth quarter, Applied sold US$327.4 million worth of equipment, a 55.8% jump compared to a year ago.

Industry analysts attributed the healthy performance to the company's strong position in all of the booming equipment markets, including the US, Korea, and the People's Republic of China. "Applied has become the Intel of the semiconductor equipment industry," said Dan Hutcheson, president of VLSI Research in San Jose. At Dataquest, analyst Clark Fuhs added that Applied has always stressed long term strategic planning. "It is no coincidence that the company is where it is today."

Applied's growth is not expected to slow down any time soon. The company said it had just received the biggest single order in its history, an US$80 million purchase from Hyundai Electronics of Korea. And Applied's backlog of orders is standing at a record US$385 million.

Just one example of Applied's tremendous success in almost anything it currently does is its line of vapour deposition products. After entering the market just three years ago, 1993 sales of those products totalled US$175 million, making Applied the market leader in that field as well.

Applied's success also reflects the stunning come back of the US equipment industry in general. According to Hutcheson, US equipment firms will command 54% of the world market in 1993, up from 51% in 1992, and the low point of 44% reached in 1990.

In 1994, Hutcheson predicted, US market share will further expand to 57%. As recently as 1989, most analysts had all but written off the US equipment industry, as their Japanese competitors were taking over key market segments. The US come back was made possible in large part because of the efforts of Sematech, which helped US equipment firms develop new products based on leading-edge technology.

Single electron memory claim

Hitachi researchers in Japan claim they have made a significant technological breakthrough, which has allowed them to demonstrate the feasibility of a single electron memory circuit. Currently, it takes about 10,000 electrons to store a single bit of data. Conceivably, a single bit memory chip could store as much as 16 gigabits of data, 1000 times the storage capacity of today's leading edge 16 megabit memory chips.

Significantly, the Hitachi researchers said their experimental circuit operates at room temperatures. In earlier experiments, the circuit used Josephson junctions and had to be cooled to close to absolute zero, making practical applications virtually impossible. ❖

Newton signed up for military duty

Although still in its infancy, military planners have already signed Apple's Newton up for service in the military in one of the biggest success stories in the short life of the personal digital assistant.

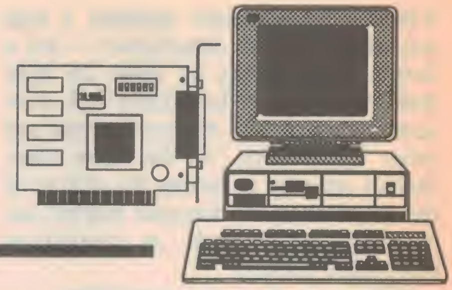
Apple has received a US$1 million test contract to help the US Army and Air Force deploy Newton in military hospitals. The Newtons are aimed at cutting red tape and improving patient care efficiency. Doctors at the Army's Reed Medical Facility in Washington DC, and the Wright-Patterson Airforce Base in Ohio will be carrying Newtons with them everywhere while on duty. They will use the devices to order tests, place prescriptions, monitor test results, and update medical records.

If Newton is a hit, the Army and Air Force are expected to purchase thousands of Newtons or similar PDAs to improve efficiency and cut the cost of operating military hospitals. The US$1 million will be used for a test project to demonstrate the feasibility of a Newton-based hospital. The program began in November and will run through to August.

The medical Newtons are programmed to minimise the use of handwriting, which has proven to be one of the machine's weak points. Instead, the software will be menu-driven with mostly boxes to be checked. At most doctors would write one of two word commands into the Newtown.

Apple said that in addition to the military program, it is also in the process of setting up Newton systems for Coca Cola, Monsanto, and American Express.

Computer News and New Products



HP Benchlink software

Hewlett-Packard has introduced a new family of software packages which allow engineers and technicians to import data from HP Basic test instruments to their personal computers (PCs). The easy-to-use Microsoft Windows based software, HP 34810A and 34811A, allows users to analyse and document test results without doing any programming.

The HP 34810 series Benchlink software can be used with the HP 54500 and 54600 series oscilloscopes and the new HP 33120A function arbitrary waveform generator. Data captured from the oscilloscopes can be displayed, saved as a file or moved to Windows-based spreadsheets, word processors, math programs or presentation software. In some cases, Benchlink enables software users to transfer waveforms from one instrument to another.

The software communicates over HP-IB or RS-232 interfaces and supports HP and National Instruments' GPIB cards. The software searches the interface for instruments, and automatically completes the connection when it finds the right instrument. No user programming or configuration is required, and no special drivers are needed with the software.

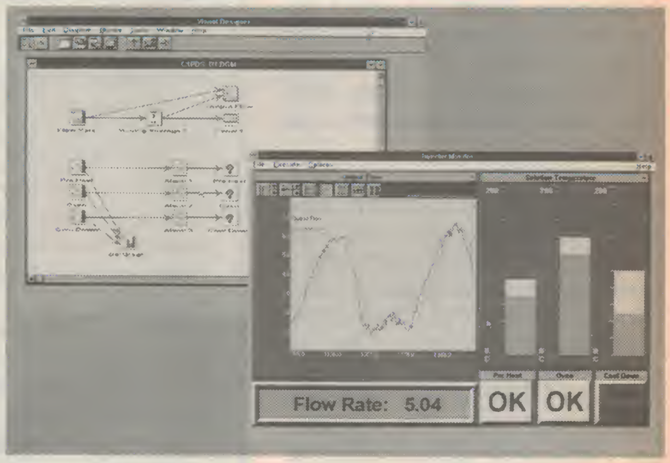
The software allows users to capture screen images and waveform data, as well as to store instrument setups and test automation sequences quickly and accurately so they can be recalled and down-loaded to the oscilloscope at another time or transferred to another oscilloscope.

Users can also create and edit their own arbitrary waveforms and send them to an HP 33120A function/arbitrary waveform generator for output. Standard sine, square, triangle and pulse waveforms can be defined graphically or through number entry. Arbitrary waveforms can be created with a freehand drawing palette or by editing standard or captured waveforms with a comprehensive editing tool palette.

For further information, call Hewlett-Packard's Customer Information Centre on 131347 (Australia wide).

Package for PC data acquisition

Intelligent Instrumentation has introduced Visual Designer — a powerful yet easy-to-use, application generator for PC-based data acquisition, test, measurement and control. With Visual Designer, custom Windows application software can be created quickly to meet a user's specific requirements — without programming. Typical applications include automotive testing, medical testing, machine monitoring, environmental monitoring, manufacturing, research and development, power utility monitoring and more.



Applications developed with Visual Designer and Intelligent Instrumentation's line of PMI data acquisition boards may be distributed royalty free. Also, unlike specialised application packages, Visual Designer offers the flexibility and wide variety of functions needed to meet most application requirements with one software package. The program can be used to capture, record, manipulate, analyse, display and output data; to control processes and devices; and to create custom instruments with chart recorders, panel meters, oscilloscopes, spectrum analysers, and more. Parameters such as sampling rates, signal ranges, triggering modes, and display or storage options can be specified to meet the exact needs of an application.

Function 'blocks' (analog and digital I/O, graphic displays, waveform generators, measurement and comparison functions, mathematical and logic operations, etc.,) are represented by icons in the block diagram (FlowGram) — each block typically replacing hundreds of lines of code in a programming language. Hence a Windows application can be created with Visual Designer in a fraction of the time it takes using a programming language.

For further information circle 161 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 878 2700, fax 878 0824.

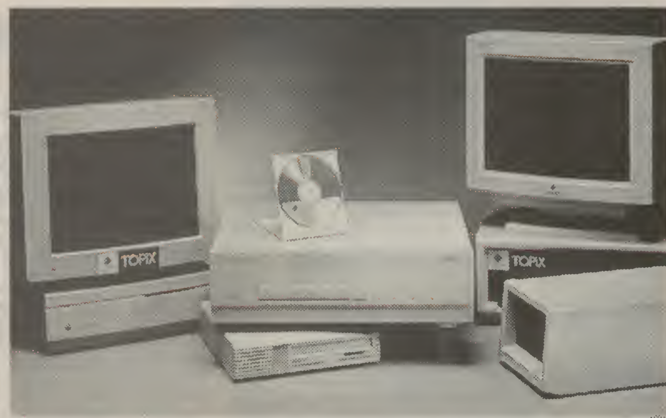
Multi-platform CD-ROM authoring

OMI's QuickTOPiX CD publishing and premastering software will work with Apple's Media Kit multimedia authoring tool to produce CD-ROMs which can be played back on Macintoshes, Microsoft Windows based PCs and other platforms.

The multi-platform CD format, known as the 'Hybrid' format, removes a major bottleneck in the development, marketing, and use of CD-ROMs — namely the need to produce a Macintosh-specific CD for Apple users and a second CD for PC users.

With this new version of OMI's QuickTOPiX software, end users of Macintosh and PC platforms will get the best of both worlds on a single disc. When working with the Macintosh, they will have the long file names and information colour icons to which they are accustomed, while if using a PC, users will play back CDs in a manner they expect.

A complete subsystem for MAC users has a suggested list price of $13,995 (excluding sales tax on hardware component), which includes all the software and hardware (double speed Philips CD-recorder) needed to get the job done.



An alternative is to have the disc cut at SCSI Corporation in its CD-R bureau.

For further information circle 163 on the reader service coupon or contact SCSI Corporation, 5/6 Gladstone Road, Castle Hill 2154; phone (02) 550 4833, fax 550 4663.

JBL CADP2 3D sound design

CADP2 is a prediction program which can be used to create quick, accurate and graphical 3D models of user-defined speaker arrays, and present comprehensive results and recommendations to clients. It is intended for architects, building engineers, acoustical consultants, electro-acoustical designers and sound contractors.

Representing the second generation of JBL's sound engineering software, CADP2 was created by combining the input from existing customers. Research had shown that sound designers wanted a predictive CAD program, with significantly reduced design and computational time, efficient data storage and expedient preparation of quotations. CADP2 meets all these user-specified needs. It is designed to take full advantage of Microsoft's Windows 3.0 and the latest generation of PCs.

With CADP2, sound designers can quickly and easily create a spatial layout of a room on any appropriate IBM compatible computer. Speakers can be placed within the 3D model and their performance predicted, and the program helps designers match the placement and performance of loudspeaker systems to room requirements.

The program features true 3D colour modelling, intuitive graphic manipulation and construction of spaces, and rapid entry of acoustic and electro-acoustic specifications. It also supports DXF protocol for the export of AutoCad architectural drawings of loudspeaker arrays, and can calculate and display amplitude, time, signal path, absorption, volume, RT(60) and intelligibility.

For further information circle 162 on the reader service coupon or contact Jands Electronics, 578 Princes Highway, St Peters; phone (02) 416 3622, fax 517 1045.

LCD projector for data, video

Electroboard's LitePro 550 is an all in one portable unit which projects video and live computer graphics, and can also capture computer images taken from IBM or Macsystems. Optimised for mobility, the LitePro 550 combines the latest advances in active matrix LCD projection.

To further simplify mobile presentations, the unit also accepts European and US video formats and power sources. It features a built-in LiteShow II presentation management system to prepare professional presentations quickly and easily. Presenters can capture images from a Mac or PC, organise, edit and time their presentations all from the one unit. The images can then be projected on a big screen without the need to connect to a computer.

Measuring only 521 x 279 x 216mm, and weighing under 10kg, the LitePro 550 has a handheld 'Smart Remote' control device, which makes it easy to control the system without interrupting a presentation. An auto-detect feature in the Smart Remote sends the appropriate, context-sensitive command with the single touch of a button.

The control allows seamless switching between video and computer sources. Also included are audio mute and video standby modes, freeze frame capability, rear projection and an on-screen menu system.

The LitePro 550 integrates full Digital Video Processing (DVP) technology, which directly translates video from the computer to the projector systems. DVP assures clean, true video. Text and data are displayed with no jagged edges. It also includes Video EQ, an image enhancement technology which allows the presenter to tune colour saturation and intensity for both video and computer graphics.

COMPUTER NEWS

The recommended retail price of the LitePro 550 is $16,900 and the LitePro 550 SL is $18,990.

For further information circle 168 on the reader service coupon or contact Electroboard, 275 Alfred Street, North Sydney 2060; phone (02) 957 5842.

486 system on a card

Priority Electronics has released the first of a range of 'All-in-One' CPU control cards. The PCA-6147 is an industrial grade 80486SX/DX/DX2-25/33/50/66MHz card, which is claimed to provide the ultimate in speed and performance in one compact package.

You can configure the PCA-6147 for different CPUs simply by changing jumpers to adjust the clock speed. The card offers memory caching, disk-drive controllers, a watchdog timer and serial/parallel ports, all in one package.

Its onboard Power On Self Test (POST) makes it simple to debug or setup. With its industrial grade construction, the PCA-6147 can withstand continuous operation in harsh industrial environments at temperatures up to 60°C.

When the PCA-6147 is plugged into a passive backplane, it turns a system into a 32-bit 486 compatible computer. Its highly compact form and numerous features make it an ideal cost/performance solution for high end industrial and commercial applications where CPU speed and mean-time-to-repair are critical. Its all-in-one configuration also frees up valuable expansion slots.

The 486 CPU's used in the PCA-6147 include 8KB of on-chip cache memory. An extra 256KB of second level cache memory is located on board. In addition to its CPU hardware, it comes with two serial ports, a parallel port, an IDE hard disk drive interface (which controls up to two hard disk drives) and a floppy disk controller (which supports up to two floppy disk drives).

An onboard watchdog timer allows the CPU to be reset, or an interrupt generated, if a program cannot be executed normally — allowing the PCA-6147 to be used in standalone or unattended environments.

Two 72-pin SIMM sockets and eight 39-pin SIMM sockets (in four banks) are provided for onboard system DRAM. These give the flexibility to configure a system from 1MB to 64MB of DRAM, using the most economical combination of SIMMs. Also, the use of cache memory allows the card to run at a Landmark (V1.14) speed greater than 200MHz (80486DX-50 CPU).

For further information circle 180 on the reader service coupon or contact Priority Electronics, 23 Melrose Street, Sandringham 3191; phone (03) 521 0266, or fax 521 0356. ❖

Tiny but flexible print server

Axis Communications, a Swedish-based developer and marketer of printer communications products and support, has released the NPS 530, a miniature printer server which connects a printer directly to a wide range of network architectures.

The NPS 530 is a 2.9 x 5.5 x 10cm device which plugs directly into the parallel port of a printer, supporting the new IEEE 1284 bi-directional parallel port standard, for data rates up to 4000kbps in burst mode.

Axis claims this capacity enables printing at full network speed. The NPS 530 connects to the network via a 10BaseT connector mounted on the side of the unit.

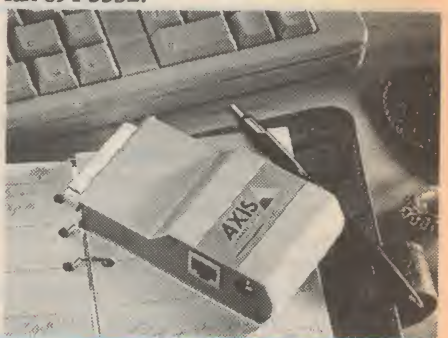
Incorporating Axis' own EXTRAX RISC-based processor, the NPS 530 offers high performance but consumes little power. It uses the printer's own 5V DC, 250mA supply coming from pin 18 of the parallel connector, eliminating battery power supplies in most cases.

As standard, the NPS 530 supports Novell NetWare from version 2.15 through to the latest version 4.0, for up to 100 print queues on up to 16 file servers. It also supports Microsoft LAN Manager 2.0 (and above) and IBM LAN Server 1.3 (and above), with NetBIOS and NetBEUI protocols.

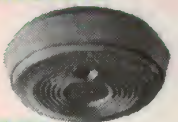
For a small additional charge, the Axis 530 will support both TCP/IP and Apple Ethertalk protocols. No PROM changes are necessary — a password (supplied by the distributor after payment of an upgrade fee) switches NPS 530 to the required mode.

The recommended retail price is $850, and TCP/IP and Apple Ethertalk upgrade options are available at $150 each (both prices excluding tax).

For further information circle 169 on the reader service coupon or contact Intelligent Technologies, 21 Cowper Street, Parramatta 2150; phone (02) 891 6010, fax 891 5532.



Now Stocking... Smoke Detectors



HPM645/2

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Excellent value at only **$15.00**. Surely your life is worth more than that?

We are also stocking the PSD2 Photoelectric Smoke Detector

Unlike the HPM unit above this one does not use a radioactive source but is triggered by visible smoke. It also features a relay output for triggering alarm systems. Operates from 12Vdc alarm supply or 9V battery. **$66.95**

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